DELAWARE RIVER BASIN COMMISSION

QUALITY ASSURANCE PROJECT PLAN 2001 UPDATE

LOWER DELAWARE MONITORING PROGRAM:

Fixed Water Chemistry Network for the Lower Non-Tidal Delaware River

and

Biological Monitoring of the Upper, Middle, and Lower Non-Tidal Delaware River

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A. Overview of the Lower Delaware Monitoring Program

In 1999, DRBC began monitoring to characterize water quality of the Lower Delaware River, extending from Trenton, NJ (River Mile 134) to the Delaware Water Gap (River Mile 210). The monitoring network was established because little data existed to characterize water quality in the reach, which has been included in the National Wild and Scenic Rivers system. In November 1999, the U.S. Senate passed legislation identifying the Lower Delaware as a scenic and recreational river. The House of Representatives followed in October 2000, and President Clinton signed the bill in November 2000. In 1997, the Lower Delaware Management Plan (Lower Delaware River Wild and Scenic River Study Task Force, August 1997) assigned DRBC as the agency to lead monitoring and development of a water quality management plan for the Lower Delaware corridor. The 1999 pilot study led to establishment of a 42-site fixed network in 2000, monitored bi-weekly through the May-September season for the purpose of defining existing water quality over a five-year period. The year 2000 results led to the 2001 program, the first of a five-year effort to develop a water quality management strategy that protects and improves the water quality of the Lower Delaware region.

From May through September of 2001, the DRBC will monitor water quality of the Delaware River and tributaries located between the Delaware Water Gap and Trenton, NJ (Figure 1). The mission of the Lower Delaware Monitoring Program is to obtain environmental data that:

- Expands and augments baseline water quality, physical, and biological data collection efforts of various federal, state, local, and citizen monitoring agencies;
- Allows statistical definition of existing water quality within five years, so that criteria may be established for development of an anti-degradation protection strategy for the Lower Delaware River corridor;

Enables reporting of water quality status and trends, biological response to natural and anthropogenic stressors, quantitative long and short-term changes to channel morphology of the river and its tributaries, and identification of key factors controlling maintenance and improvement of the ecological integrity of the river;
Supports determination of abatement priorities for point and non-point sources of pollution;
Allows prioritization of tributaries for monitoring and watershed planning purposes;
Expands ecological knowledge of the Lower Non-Tidal Delaware River; and
Helps to safeguard the health and safety of the river-using public.

The monitoring program consists of two components: routine baseline monitoring, including water chemistry and physical parameters, and biological monitoring. The chemical/physical component has been established. The biological component is in formative stages, and implementation will depend upon results of an exploratory study to be conducted in August-September 2001.

May to October 2001 Sampling Activities:

Bi-weekly chemical/physical sampling at 9 bridges over the Delaware River (composite samples across a 3-site transect), and on 14 tributaries to the Delaware River between the Delaware Water Gap and Trenton, NJ. Beginning on May 8, 2001, we will collect water quality information every other week until the end of September 2001. It is anticipated that 10 samples per site will be collected from 23 sites.

Fluvial geomorphology investigations, undertaken in recent years, will continue in a few tributary watersheds. Wickecheoke Creek and Lockatong Creek, Hunterdon County, NJ, will be assessed for channel stability, sediment supply, and riparian condition using methods developed by Simon (1989), Simon and Hupp (1992), Simon and Downs (1995), Rosgen (1994, 1996), Pfankuch (1975), and Lisle and Hilton (1992). This continues studies of Wickecheoke and Lockatong Creeks begun in 2000.

Stream discharge monitoring will take place in 10 tributaries to the Delaware River. Flow rating curves will be established for tributaries without USGS stream gages, so that pollutant loadings may be calculated in non-point source pollution assessments of watersheds.

Macroinvertebrate monitoring of the Delaware River will be based on best available habitat (riffle-run-island margin) during the August-September index period. Three samples will be collected from each of approximately 33 sites along the Delaware River corridor, extending from the East and West Branches above Hancock, NY, to the fall line at Trenton, NJ. This is the first season of five toward development of a benthic Index of Biotic Integrity (B-IBI) for the non-tidal Delaware River. Primary activities will include benthic sampling and habitat delineation of representative reaches within physiographic provinces crossed by the Delaware River.

II. Project Organization and Responsibility

Staff Assignments: Fixed Chemistry Network

Robert Limbeck, M.S., Program Manager
Todd Kratzer, M.S., Lower Delaware Team Leader
Geoffrey Smith, B.S., Field Technician & Aquatic Biologist
Edward Santoro, M.S., DRBC Quality Assurance Officer
Dr. Thomas Fikslin, Ph.D., Monitoring & Modeling Branch Head
David Pollison, Advisor to the Commission
Lance Miller, Planning and Implementation Branch Head (Acting)
Temporary Field/Lab Workers: Matthew Hoyt, Jessica Ciottoni

Staff Assignments: Biological Monitoring

Delaware River Basin Commission:
Robert Limbeck, Environmental Scientist, Project Manager L. Del. / SRMP Monitoring
Todd Kratzer, Water Resources Engineer, Lower Delaware / Scenic Rivers Team Leader
Lance Miller, Acting Planning & Implementation Branch Head (Advisor/Administrator)
Dr. Thomas Fikslin, Modeling & Monitoring Branch Head (Advisor/Administrator)
Edward Santoro, Monitoring Coordinator (QA/QC & External Program Coordination)
Geoffrey Smith, Field Technician (Biomonitoring, Chemistry, Taxonomy)
Temporary Field/Lab Workers: Matthew Hoyt, Jessica Ciottoni

National Park Service: Middle Delaware Scenic & Recreational River:
Pat Lynch, Chief, Research & Recreation (Administration & Supervision)
Allan Ambler, Biologist (Scenic Rivers Program Manager)

National Park Service: Upper Delaware Scenic & Recreational River:
Michael Reuber, Chief, Resource Management (Administration & Supervision)
Don Hamilton, Biologist (Scenic Rivers Program Manager)
Jamie Myers, Biologist (Scenic Rivers Monitoring Program)

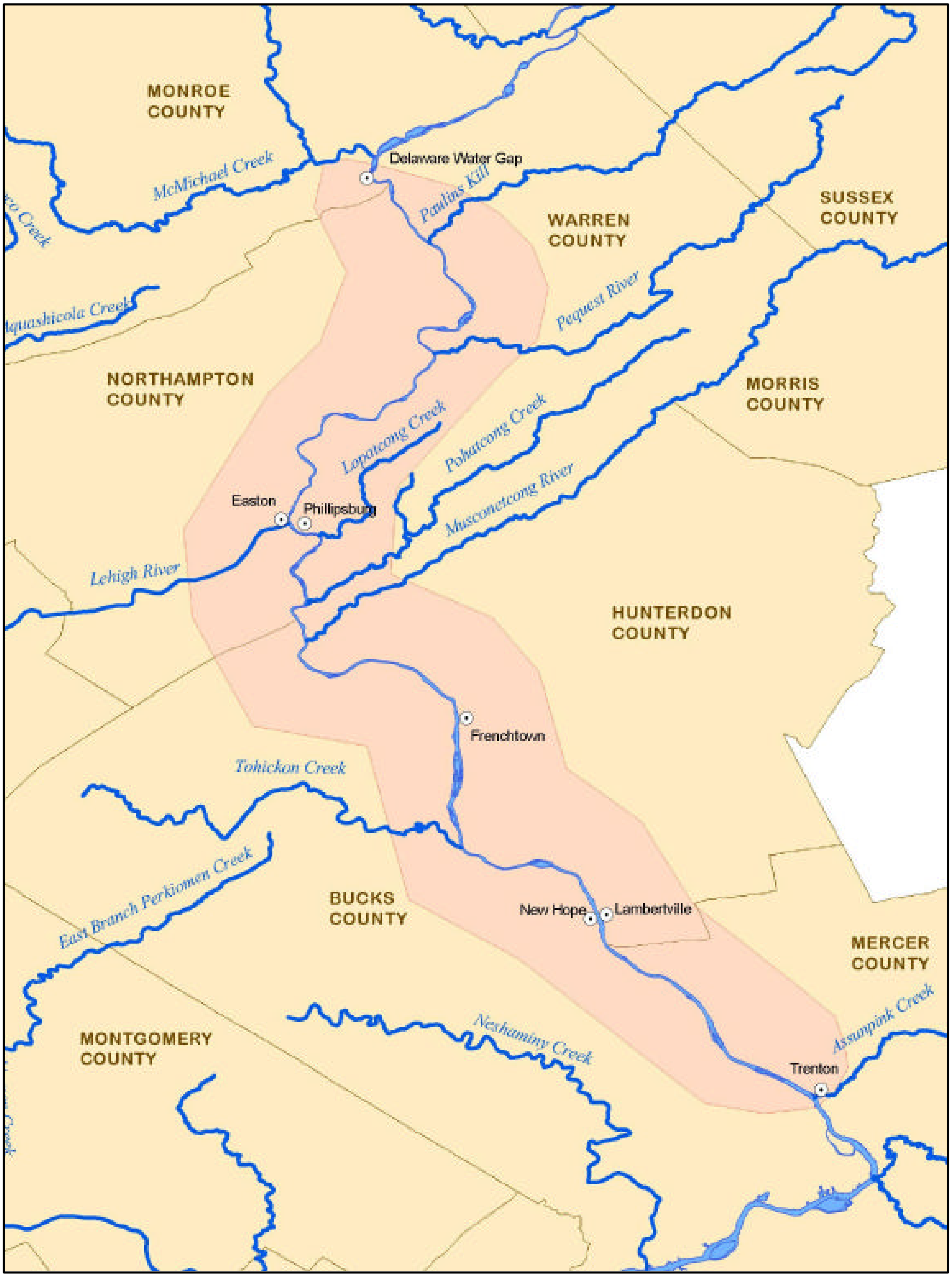

Figure 1. Lower Delaware Monitoring Program Study Area

III. QA Objectives

The QA Objectives of the Lower Delaware Monitoring Program are:

To accurately describe the water quality and related biological conditions in the study area. The water quality parameters should be sufficient to:

1. Evaluate the quality of the waters within the Lower Delaware River region;
2. Categorize tributaries and river locations as point source or non-point source impacted;
3. Rank tributaries and river locations for water quality management actions including follow-up monitoring and intensive surveys by state enforcement agencies;
4. Identify whether water quality meets or exceeds standards related to designated uses; and,
5. Ascertain relative water quality impact on the biological resources of the study area.

Attainment of quality assurance objectives will be achieved by maintaining a running check of precision and accuracy of analyses throughout the sampling program. Before the start of the program, the quality assurance officer and program manager conducted a laboratory audit. During the monitoring season, field sampling protocol audits will be conducted monthly. Instrument variations will be controlled by calibration of equipment and use of standard solutions. The observed accuracy will be compared to design accuracy found in Table 1. To reduce bias of dissolved oxygen and pH values due to same time of day sampling, the sequence of station visits will periodically be altered to insure that data represent daily variability. Comparability of data sets will be determined by examining data using the Student t-test. Internal and external quality control checks used to determine the accuracy of analyses are described in Section VII. The specific procedures to determine data precision, accuracy, and completeness are described in Section X. All problems are immediately reported to both the program manager and the quality assurance officer, a report is prepared in the form of a DRBC memorandum, and resolution is sought before continuance of the program.

Table 1: Lower Delaware Monitoring Program Parameters

Parameter	Standard Methods Procedure	Equipment	Min – Max	Accuracy(±)
COLLECTED AND ANALYZED BY DRBC:				
Flow Discharge	See TABLE 2 for locations	Pygmy meter	0.07-3.00 fps	
Gage Height	N/A	Surveyor's Tape	N/A	0.01 ft
Air temperature	2550 – thermometric	Thermometer	-10-110 °C	1 °C
Water temperature	2550 – thermometric	Thermometer	-10-110 °C	1 °C
		Probe (DO meter)	-5-45 °C	0.7 °C
		Probe (cond. meter)	-2-50 °C	0.6 °C
Dissolved oxygen	4500-O C. - azide modification of Winkler titration method	Pre-prepared Hach kit	0-20 mg/l	20-60 μg/l
	4500-O G. – membrane electrode	YSI Meter	0-20 mg/l	1% of scale
Specific conductance	2510 B. Laboratory Method (platinum electrode cond. cell)	YSI Meter	0-19,999 μmhos /cm	2 μmhos/cm
PH	4500-H+	Oakton pH Testr 2	4-10 units	0.25 units
PH	4500-H+	IQ 120 pH meter	2-12 pH	±0.1 units
COLLECTED BY DRBC: Contracted with NJ Analytical Labs for analyses (LRL is Lower Reporting Limit).				
Hardness (Total)	EPA 130	1 mg/l CaCO3 LRL	7 d hold time	±1 mg/l
Chloride	EPA 325.3	1 mg/l LRL	7 d hold time	±1 mg/l
Alkalinity, Total	EPA 310	1 mg/l CaCO3 LRL	24 hr hold time	±1 mg/l
Turbidity (NTU)	EPA 180.1	5 NTU LRL	24 hr hold time	±1 units
Enterococcus	9230 C. mE agar enterococci MF	>0 /100ml LRL	6 hr hold time	NA
Fecal coliform	9222 D. m-FC media (MF)	>0 /100ml LRL	6 hr hold time	NA
Nitrate+Nitrite	EPA 353.2, 353.3	0.05 mg/l as N LRL	7 d hold time	0.05 mg/l
Chlorophyll a	SM 10200 H.	0.001 mg/m3 LRL	24 hr hold time	0.001 mg/m3
Ammonia N	EPA 350	0.1 mg/l NH3 as N LRL	7 d hold time	0.1 mg/l NH3 as N
Total Phosphorus	EPA 365.1	0.005 mg/l PO4 as P LRL	7 d hold time	0.005 mg/l PO4 as P
Total Kjeldahl Nitrogen	EPA 351.2	0.1 mg/l TKN LRL	7 d hold time	0.1 mg/l TKN
Orthophosphate P	EPA 365.1	0.005 mg/l PO4 as P LRL	24 hr hold time	0.005 mg/l PO4 as P
Total Suspended Solids	EPA 160.2	4 mg/l LRL	24 hr hold time	4 mg/l
Total Dissolved Solids	EPA 160.1	10 mg/l LRl	24 hr hold time	10 mg/l

DRBC BIOMONITORING – Macroinvertebrates and habitat for tributaries and Delaware River.	
Habitat Assessment (wadeable tributaries)	RBP 2nd Edition 1999, Habitat Protocols for High Gradient Streams (tributaries). Sampled as needed.
Habitat Assessment (Delaware River – special project)	USGS NAWQA Protocols (Fitzpatrick et al. 1998) in Delaware River OR Adaptation of RBP Habitat (2nd Ed., Barbour et al. 1999) to Delaware River. This is used to identify & quantify extent of riverine microhabitats for macroinvertebrates.
Macroinvertebrates (Rapid Assessment in Tributaries)	Indicator-organism field-level assessment w/ 10 point scoring system. Adapted from NYSDEC screening procedure developed by Bode et al. 1996. Assess 100 m reach upstream of fixed water quality sampling site. Sample as needed. If score < 5, call state for further investigation.
Macroinvertebrates (Delaware River Metric Development)	Best habitat (riffle, run, or island head), 33 sites, 3 replicates, 200-organism subsample of Delaware River from East & West Branches to Trenton, NJ. Index period is August-September, flow must be less than 6,000 cfs @ Trenton for access. Sampled annually.

Table 2: Flow Measurement Monitoring Locations, Delaware Water Gap to Trenton

Location		Agency	Type
Active U.S. Geological Survey Stream Gages in Lower Delaware Corridor			
** denotes availability of current data on worldwide web at http://waterdata.usgs.gov/nwis-w/			
01443280	East Branch Paulins Kill nr Lafayette, NJ	USGS	Continuous
01443500	Paulins Kill at Blairstown, NJ	USGS	Continuous
01443900	Yards Creek nr Blairstown, NJ	USGS	Continuous
01445500	Pequest River at Pequest, NJ	USGS	Continuous
01446500	Delaware R. at Belvidere, NJ	USGS	Continuous**
01447500	Lehigh R. at Stoddartsville, PA	USGS	Continuous**
01447800	Lehigh R blw FE Walter Res nr White Haven, PA	USGS	Continuous**
01449000	Lehigh R at Lehighton, PA	USGS	Continuous**
01451000	Lehigh R at Walnutport, PA	USGS	Continuous**
01453000	Lehigh R at Bethlehem, PA	USGS	Continuous**
01454700	Lehigh R at Glendon, PA	USGS	Continuous**
01457500	Delaware R. at Riegelsville, NJ	USGS	Continuous**
01457000	Musconetcong River nr Bloomsbury, NJ	USGS	Continuous
01460200	Delaware R. at Point Pleasant, PA (QW Site Only)	USGS	DO, pH, Temp, Cond.
01459500	Tohickon Cr nr Pipersville, PA	USGS	Continuous**
01463620	Assunpink Creek nr Clarksville, NJ	USGS	Continuous
01464000	Assunpink Creek @ Trenton, NJ	USGS	Continuous
01463500	Delaware R. at Trenton, NJ	USGS	Continuous**
DRBC Flow Monitoring - Develop Flow Rating Curves for Loadings (10 Creeks)			
Pidcock Cr at Bowmans Hill Wildflower Preserve, Bucks Co, PA		DRBC	Instantaneous
Wickecheoke Cr at Rt 29 nr Prahls Mill, Hunterdon Co, NJ		DRBC	Instantaneous
Lockatong Cr at Rosemont-Raven Rock Rd, Hunterdon Co, NJ		DRBC	Instantaneous
Paunacussing Cr nr Rt 32, Bucks Co, PA		DRBC	Instantaneous
Tinicum Cr nr Rt 32, Bucks Co, PA		DRBC	Instantaneous
Tohickon Cr abv Rt 32, Bucks Co, PA (relate to upstr USGS gage)		DRBC	Instantaneous
Nishisakawick Cr, Hunterdon Co, NJ		DRBC	Instantaneous
Cooks Cr abv Red Bridge Rd, Bucks Co, PA		DRBC	Instantaneous
Pohatcong Cr abv River Rd, Warren Co, NJ		DRBC	Instantaneous
Bushkill Cr abv Rt 611, Northampton Co, PA		DRBC	Instantaneous

IV. Sampling Procedures

A. Selection of Sampling Sites – Water Chemistry Fixed Network

Twenty-three (23) long-term monitoring sites will be sampled biweekly for Table 1 parameters.

Rationale for choice of locations

Delaware River Water Quality Monitoring Sites (9 bridges) were chosen based on accessibility; equidistance along the river corridor; physiographic regional location, coordination/comparison with other agencies; and location relative to major tributaries or known problem areas. Three monitoring sites are located at each bridge, at one-third of the channel width along the Pennsylvania side and one-third of the channel width along the New Jersey side of the river, and at center channel. Composite samples are combined from the three locations across the transect.

Table 3. Delaware River Water Chemistry Monitoring Sites

Delaware River Bridge	River Mile	Site Numbers (composite, NJ side, PA side)
Calhoun Street Bridge	134.34	DRBCNJPAC01, DRBCNJ0001, DRBCPA0001
Washington Crossing Bridge	141.80	DRBCNJPAC02, DRBCNJ0004, DRBCPA0006
Lambertville/New Hope Bridge	148.70	DRBCNJPAC11, DRBCNJ0009, DRBCPA0010
Stockton Bridge (not monitored 2001)	151.90	DRBCNJPAC03, DRBCNJ0011, DRBCPA0012
Raven Rock/Lumberville Foot Bridge, Bulls Isl.	155.40	DRBCNJPAC04, DRBCNJ0014, DRBCPA0013
Frenchtown/Uhlerstown Bridge (closed 2001)	164.30	DRBCNJPAC05, DRBCNJ0021, DRBCPA0018
Milford/Upper Black Eddy Bridge	167.70	DRBCNJPAC06, DRBCNJ0024, DRBCPA0019
Riegelsville Bridge	174.80	DRBCNJPAC07, DRBCNJ0026, DRBCPA0023
Easton/Phillipsburg Bridge, Northampton St.	183.80	DRBCNJPAC08, DRBCNJ0029, DRBCPA0027
Belvidere/Riverton Bridge	197.80	DRBCNJPAC09, DRBCNJ0034, DRBCPA0033
Columbia/Portland Foot Bridge	207.40	DRBCNJPAC10, DRBCNJ0037, DRBCPA0036

Tributary Water Chemistry Monitoring Sites (14) include tributaries selected for Lower Delaware Wild and Scenic Rivers (W&S) designation, PA High Quality (HQ) or Exceptional Value (EV) Waters, NJ Trout Maintenance (TM) or Trout Production (TP) Waters, or are streams which contribute a significant flow to the Delaware and are important hydrologic or pollutant loading influences. Some sites were chosen as comparison sites with other monitoring programs such as the Pennsylvania DEP's Water Quality Network (WQN) and New Jersey DEP's Ambient Surface Water network (ASW). Additional criteria for selection of a tributary included known problems, development pressure, and local interest or existence of a volunteer watershed group. Data will be collected from other agencies to supplement DRBC's database for the Lower Delaware, and to verify the accuracy of each agency’s data.

Table 4. Tributary Water Chemistry Monitoring Sites

Tributary	Mile	Reason for Selection 2001	Site No.
Pidcock Cr, PA	146.3	Good quality, potential reference site	DRBCPA0008
Wickecheoke Cr, NJ	152.5	W&S, TM, development	DRBCNJ0012
Lockatong Cr, NJ	154.0	W&S, TM, development	DRBCNJ0013
Paunacussing Cr, PA	155.6	W&S, HQ, watershed group	DRBCPA0016
Tohickon Cr, PA	157.0	W&S, EV, regulated, major tributary	DRBCPA0015
Tinicum Cr, PA	161.6	W&S, EV	DRBCPA0017
Nishisakawick Cr, NJ	164.1	ASW	DRBCNJ0020
Cooks Cr, PA	173.7	W&S, EV, infrequent samples, watershed group	DRBCPA0021
Musconetcong River, NJ	174.6	ASW, TM, major tributary, watershed group	DRBCNJ0025
Pohatcong Cr, NJ	177.4	TP, reservoir effects, development, watershed group	DRBCNJ0027
Lehigh River, PA	183.66	WQN, regulated, major tributary, watershed groups	DRBCPA0026
Bushkill Cr, PA	184.1	EV (pt), known problems, watershed group	DRBCPA0028
Pequest River, NJ	197.8	ASW, TM, major tributary, watershed group	DRBCNJ0032
Paulins Kill, NJ	207.0	W&S, TM, ASW, major tributary	DRBCNJ0036

Not Monitored 2001, Sites Established for Definition of Existing Water Quality

Tributary	Mile	Reason for Exclusion 2001	Site No.
Assunpink Creek, NJ	133.8	Lack of funds, NJDEP monitors (303D listed)	DRBCNJ1338
Buck/Brock Cr, PA	138.0	Lack of funds, not major tributary	DRBCPA0002
Jacobs Cr, NJ	140.5	Lack of funds, not major tributary	DRBCNJ0003
Aquetong Cr, PA	148.5	Lack of funds, not major tributary (PA HQ stream)	DRBCPA0009
Hakihokake Cr, NJ	167.2	Lack of funds, not major tributary (NJ TM waters)	DRBCNJ0023
Fry's Run, PA	176.6	Lack of funds, not major tributary (PA HQ stream)	DRBCPA0024
Lopatcong Cr, NJ	182.0	Lack of funds, not major tributary (NJ TP waters)	DRBCNJ0028
Martins Cr, PA	190.58	Lack of funds, not major tributary	DRBCPA0031
Buckhorn Cr, NJ	192.9	Lack of funds, not major tributary (NJ TP waters)	DRBCNJ0030

The 2001 monitoring matrix specifies composite and grab sample locations (see Appendix A).

B. Biological Monitoring

Delaware River

During 1999 and 2000, DRBC staff met with monitoring counterparts representing the Pennsylvania DEP, New Jersey DEP, and the USGS National Water Quality Assessment (NAWQA) Delaware Basin Study Unit team members. All agencies expressed the need for biological monitoring of the Delaware River, and expect DRBC to lead main stem Delaware River biological monitoring. A comprehensive biomonitoring program should include examination of multiple assemblages and communities, including fish, macroinvertebrates, periphyton, submerged aquatic macrophytes, and phyto- and zooplankton. Management priorities, lack of funds, and staff limitations prevent implementation of such an effort.

However, given existing resources, certain activities may be undertaken to provide a biological monitoring component to Delaware River water quality monitoring. Complementary to DRBC's physical and chemical data gathering, macroinvertebrate monitoring should provide a more well-rounded view of water quality conditions in the Delaware River, and should provide sufficient data for scientifically-based decisions regarding protective and preventative management of a known high-quality resource.

DRBC will begin with reconnaissance of the river, basic macroinvertebrate collections, and methods investigations during the summer and fall of 2001, continuing at least through 2005. By supplementing the traditional water chemistry monitoring with biological and geomorphological investigations, DRBC intends to gather sufficient information to serve the following needs:

<u>Implement Special Protection Waters regulations adopted in the early 1990's for the upper 120 miles of the Delaware River</u>. In 1991, DRBC ruled to provide anti-degradation protection of high water quality in the Upper (Upper Delaware Scenic and Recreational River, or UPDE) and Middle Delaware River (through the Delaware Water Gap National Recreation Area, or DEWA). In 1995, DRBC and the National Park Service (NPS) re-designed the Scenic Rivers Monitoring Program so that Special Protection Waters implementation and effectiveness could be monitored. It was subsequently found that the program's chemistry monitoring frequency should be increased to a minimum of 10 samples per season, per site, so that measurable changes to water quality could be detected at a 95% degree of confidence (as mandated in DRBC's Water Quality Regulations). STATUS: As of 2001, the current chemistry-only monitoring program does not serve this need. No biological criteria were implemented, though they were mandated for the Delaware River and tributary Boundary Control Points.

<u>Develop data sufficient to define Existing Water Quality; protect areas of known high water quality; and improve water quality in impaired areas of the Lower Non-Tidal Delaware River (80 miles)</u>. These goals were mandated in the 1997 Lower Delaware Management Plan, supported by the Wild and Scenic Rivers Act designation of selected areas in 2000, and supported by DRBC resolution in 1998). STATUS: The current chemical monitoring component meets this need only partially. No quantitative biological criteria currently exist for the Lower Non-Tidal Delaware River or near-confluence tributary locations.

Develop a Benthic Index of Biological Integrity (B-IBI) for the non-tidal Delaware River. Starting with an intensive 3-year macroinvertebrate survey of accessible river sites, targeting the richest-available habitats (riffles, runs, island margins), a B-IBI will be developed to quantify ecological integrity of the entire 200-mile non-tidal river. Once the 3-year reference baseline is developed (years 2001-2003), further testing (years 2004-2005) of the most sensitive metrics for detecting 'measurable change' will be refined and incorporated into a B-IBI useful for protecting long-term ecological integrity of the river. The B-IBI numerical reference values will be proposed to set an anti-degradation level of protection for the river's aquatic life, and to provide an "existing water quality" biological baseline for assessment of long-term changes, serving both of the objectives listed above.

B-IBI Design Limitations: As designed, the B-IBI serves only the Delaware River, not tributaries. Initially, the biomonitoring program will strictly limit spatial and temporal variation by narrowly defining methods and times for sample collection. In 5 years, the B-IBI will be applicable only to extended low water periods in late summer, within richest-available habitat conditions. Use of the B-IBI will be limited to similarly sampled locations. This ensures that changes detected in the benthic macroinvertebrate assemblage are due to changes in water quality and not due to natural variability. This narrowly limited scope of design provides high-quality data for the critical low-flow season, while keeping costs down and keeping the scope of study manageable under existing staff levels. The B-IBI will be used to detect changes in water quality from year to year and from site to site along the longitudinal river corridor. It was not designed for use during any season, under high flow conditions, in poorer habitat conditions such as deep pools or muddy substrates, or to be representative of the entire Delaware River Basin watershed area. The B-IBI is designed as a fixed, longitudinal survey, comparing riffles to riffles, upstream-to-downstream, along the river corridor.

Recent Biological Studies of the Delaware River: In the Middle and Upper Delaware River, macroinvertebrates were studied between 1995-1997 by the Academy of Natural Sciences and the National Park Service (final reports pending, R. Evans, NPS, personal comm.), with DRBC field assistance. Results indicate that two watersheds in that study area were biologically impaired (Brodhead and Callicoon Creeks); one river site consistently scored poorly (Delaware River at Bushkill Access Area); and sampling, sorting, and counting procedures should be more robust and efficient. DRBC and NPS intend to use results of the mid-1990's study to refine biological monitoring protocols and provide high quality biological data toward implementation of DRBC's Special Protection Waters rules.

Other issues of concern to the DRBC merit an expanded monitoring program covering the Delaware River and selected tributaries upstream of Trenton, NJ. DRBC recognizes the need to expand water quality monitoring of the Lower Delaware River while not duplicating the work of the Basin states. Continued support of the DRBC/NPS Scenic Rivers Monitoring Program is necessary, especially as DRBC implements its Special Protection Waters regulations. As DRBC re-evaluates minimum flow targets for the main-stem Delaware River, a need exists to characterize the water quality, ecological integrity, and habitat quality of the River's non-tidal length. In addition to these needs, the USEPA has expressed desire for increased collection of nutrient data, development of biological criteria for large rivers, and use of biological data for assessment of river reaches for the bi-annual water quality assessment under section 305(b) of the Clean Water Act. In addition to traditional water chemistry monitoring, the following activities will be used to protect aquatic life, describe the ecology and habitat quality, and provide a direct measure of water quality in the non-tidal Delaware River. No 2001 activities are scheduled regarding monitoring of periphyton, phytoplankton, or zooplankton.

Task 1. Macroinvertebrates – Non-Tidal Delaware River Annual Survey (High Priority)

During a stable, low-flow index period in August and September, we will collect approximately 93-99 samples, depending upon site access and habitat availability. Collection gear will be an oversized 2' x 3' rectangular frame net, 500µ mesh, with a 2' x 2' bottom frame to delineate the disturbed area (4 sq. ft. or 0.37 m^2), hereafter referred to as the Big River Frame Net, or BFN. At selected locations, we will compare the BFN to a standard D-frame dip net (500µ) as well as the historically used Portable Invertebrate Box Sampler (PIBS). Statistical comparisons will be made between these samplers for the following properties: complete capture of benthic assemblage; sampler ability to overcome patchy macroinvertebrate distribution; replication of method; and variability of metrics. We will sample the best available habitat (riffle, run, or island margin), taking 3 replicates at 31-33 sites. In the laboratory, we will sub-sample 200-organisms, identify to genus (chironomidae to family), and calculate metrics listed in the 1999 Rapid Bioassessment Protocols (USEPA 1999). Sites include locations accessible to wading along the non-tidal Delaware River from Trenton, NJ to Hancock, NY, as well as locations on the East and West Branches of the Delaware River. Locations suitable for wading are well known in the Middle and Upper Delaware, but must be explored in the Lower Delaware. Exploration of Lower Delaware sites will take place in early August 2001. For safety, an operating rule is established that the Delaware River's discharge at Trenton must be less than 6000 cfs. All sites will be documented by map & GPS.

Additional Uses of Data: During the initial three years, we will use the annual survey to build our reference collection of river invertebrates. After the 200-organism sub-sample work-up, we will pick the entire sample and identify to the lowest a possible taxon. We will verify taxonomy using another lab; note rare species and document field observations as well as literature-searched occurrence / habits / life history, etc. We plan to prepare a guide to benthic invertebrates of the Delaware River. We will contribute data to any and all interested individuals, agencies, and institutions, such as the Pennsylvania Aquatic Diversity project conducted by The Nature Conservancy. We will also use the data to demonstrate optimal use of the STORET data system.

Task 2. Macroinvertebrates - Tributaries – Field-Level Assessment (Low Priority)

(This activity is low priority until DRBC, NPS, and States create a quantitative criteria development process for boundary control points. Based upon results of the mid-1990's NPS/Academy study, methods and sites will be determined by an interagency technical committee, and reporting to the DRBC Water Quality Advisory Committee or Monitoring Advisory Committee).

This is DRBC's interim macroinvertebrate monitoring method to rapidly and inexpensively characterize biological quality of tributary inputs to the Delaware. It is used to note changes between site visits, and to trigger watershed-scale investigations. Advantages of using this indicator organism based method are numerous: it is applicable to all high gradient streams, results are cheap, methods are replicable by minimally trained staff or volunteers, and the field level investigations results in very fast turnaround of information. It is not intended for 305B or 303D use. PADEP or NJDEP methods are used for those assessments.

Applicable to all high-gradient wadeable tributaries to the non-tidal Delaware River (approximately 80 sites). See DRBC Macroinvertebrate Field Assessment Sheet (Exhibit 4). Rectangular frame dip net, 500 µ, best habitat, 3 riffle composite. If impairment found (field score < 5), or if sample is especially high quality (field score 9 or 10), bring sample back for full workup (200-organism sub-sample, etc.). Poor field score triggers watershed investigation of possible stressors. Record details of land use, riparian corridor, site conditions. Notify state of investigation, provide report within 1 month to PADEP regional offices or NJDEP Ambient Biomonitoring Unit. Integrate citizen volunteer information wherever practical.

Task 3. Habitat Assessment - Delaware River – 6 reaches 1000m (High Priority)

Habitats must be defined for the benthic index and characterization of the Delaware River. In the non-tidal Delaware River, habitats are not well known, and little information exists about proportional composition of common, uncommon, or special aquatic habitats worthy of additional protection.

In July-August 2001-2002, we will use the NAWQA or adapted RBP habitat protocols to a large river setting. Use 2 representative reaches (1000m/ea. length) in Appalachian Plateau, Valley & Ridge, and Piedmont provinces Delineate proportions of up to 51 known microhabitats defined by Cuffney et. al (1993). Most common or best habitats will be used for IBI development (each discrete & common habitat will eventually be studied and possibly used in it's own specific IBI for long-term monitoring, depending on data availability and practical usage). In time, we should be able to define the existing, best-expected benthic assemblage inhabiting not only riffles, but also in poorer habitats such as pools, macrophyte beds, flood-prone areas, etc. Special studies of biota of each discrete habitat will be prioritized during the initial 3-year descriptive period.

Task 4. Habitat Assessment of Tributaries (Low Priority)

RBP Habitat (1999 Protocols) will be sampled concurrently with tributary macroinvertebrate assessments. Use modifications: add pebble count in riffles, Pfankuch evaluation of bank stability, and vegetation quality & gully frequency along riparian corridor (can riparian area stop non-point pollutants during storm?). Develop detailed reach maps for future reference, and identify riffles for cross-section surveys and geomorphological description. Identify the Rosgen (1994) stream type of each reach, and note potential reference reaches for application of natural channel design restoration techniques.

Task 5. Delaware River Submerged Aquatic Vegetation (SAV) Survey (Medium Priority)

Aquatic vegetation growth or overgrowth is a major water quality determinant in the Lower Delaware. A SAV survey quantifies amount of primary producers necessary to effect water quality changes. The survey also will be used to describe the river's plant community, and will serve as a reference for assessment of change brought about by river conditions and invasive exotic species.

A Submerged Aquatic Vegetation (SAV) survey will be used to monitor plant activity in the Delaware River. When significant effects are observed in our bi-weekly chemistry samples (wide range of DO daily periodicity, pH values above 8.5), we will survey plant beds located in river segments using a protocol developed by Kratzer (1999). Delineation of plant beds, identification of SAV species, representative sampling of density / size classes for each species, drying of sample (USGS?) and calculation of plant biomass will be conducted in affected reaches. We will attempt to relate plant production to water quality changes, especially for nutrients. We will collect macroinvertebrates concurrently from SAV habitat.

Task 6. River Corridor Survey of Invasive/Exotic Species (Medium Priority)

Extent of invasive exotics, and the degree of displacement of the native plant community should be documented along the Delaware River. Effects on quality of the river's riparian corridor, and relationships to water quality are unknown, and believed negative.

In July and August 2001, we will survey riverbanks during the SAV survey and during macroinvertebrate collection trips. Map out extent and location of problem plants on DRBC river recreation maps, and transfer to ArcView GIS. Where plants are dominant in their occurrence, the following invasive exotics will be mapped: Japanese Knotweed; Purple Loosestrife; Oriental Bittersweet; Multiflora Rose; the aquatic Water Milfoil; and the nuisance filamentous algae Cladophora). We will report results to a regional invasive exotics species council (Morris Arboretum / NPS), and will distribute information via DRBC's web site.

Task 7. Fish Tissue Analysis (High Priority)

DRBC will assist State or USGS surveys as necessary. For summer 2001, DRBC contracted out fish tissue sampling to NJDEP for three locations along the non-tidal Delaware River (near Milford, NJ; near the Lehigh River confluence; and at Montague, NJ). The Academy of Natural Sciences, Patrick Center for Environmental Research will conduct fish tissue analyses on two species, smallmouth bass and white suckers.

C. Fluvial Geomorphology Studies (Medium Priority)

DRBC began using applied fluvial geomorphology in the mid-1990's to assess channel stability, stream bank stability, sediment loading, and success or failure of stream restoration techniques in several watersheds of tributaries to the Lower Delaware. Waterways currently being assessed include: Wickecheoke Creek, NJ; Lockatong Creek, NJ; and Pocono Creek, PA. Techniques include: Rosgen (1996) Level I, II and III classification and assessment of stream condition and departure; Simon's channel evolution model (Simon 1989, Simon and Hupp 1992, Simon and Downs 1995); Lisle and Hilton's (1992) index of fine sediment supply in pools; Pfankuch's (1975) channel stability evaluation; and the pebble count method for evaluation of surface bed materials (Wolman 1954, Potyondy and Hardy 1994, Kondolf 1997). It is anticipated that these investigative methods studies will increase resolution of habitat assessments, particularly in relating the physical, chemical, and biological responses to sedimentation in streams.

Table 5. Annual Delaware River Macroinvertebrate Assessment (Est. 33 sites)

SAFETY NOTE: The Delaware River is deemed unsafe for wading when the flow at Trenton is more than 6,000 cfs, especially in the reach between the Delaware Water Gap and Trenton. Check flows before leaving in the morning.

Tasks/Products (August-September Index Period)
Substrate analysis of sampling locations (pebble count technique); Velocity profile (across transect & through net)
3 Macroinvertebrate samples from best available habitat (riffle, run, channel margin)
- use 2x3'big-river net (500m mesh), 0.37 m kick area. 75% ETOH preservation, lab process 2001/2002.
Site Map (as detailed as possible, including depths, widths, riparian land use, habitat proportions), location

Site No.	Location (river mile)
Through Lower Delaware SRR (Lower Delaware) – locations not set until August 2001 exploration	
DEL1344	Just upstream of Calhoun Street Bridge, PA side (134.4)
DEL1371	NJ side of Rotary Island, near center cross channel (137.1)
DEL1400	Scudders Falls area, vicinity of wing dams, NJ side (140.0)
DEL1440	at entrance to Washington Crossing St Pk, blw Jericho Cr confl (144.0)
DEL1478	0.2 mi downstream of Lambertville wing dam, (147.8)
DEL1520	upstream Rt. 263 Bridge @ Stockton, NJ (152.0)
DEL1555	bar on PA side blw Paunacussing Cr confluence, abv Bulls Isl footbr (155.5)
DEL1589	off headward end of Prahl's Island (158.9)
DEL1637	0.6 miles downstream from Frenchtown bridge, by Pennington Island (163.7)
DEL1701	1.5 miles upstream from Upper Black Eddy (170.1) DS of power lines
DEL1742	Riegelsville Access Area, PA riffle area DS of access (174.2)
DEL1832	Phillipsburg Access Area, NJ, just downstream of Lehigh River (183.2)
DEL1839	Phillipsburg Access Area, NJ, just upstream of Lehigh River (183.9)
DEL1892	Sandt's Eddy Access just downstream of Martins Creek confluence (189.2)
DEL1944	PPL Martins Creek access area, downstream of generating station (194.4)
DEL1971	0.5 miles downstream from Belvidere Access, NJ (197.1)
DEL2073	upstream of Route 611 bridge at Portland, PA (207.3)
Through Delaware Water Gap NRA (Middle Delaware)	
DRBC/NPS2116	Kittatinny Access (Historic DRBC/NPS Biomonitoring Site)
DEL215	Worthington Access (NJ), 3.0 mi. upstream of DWGap (Brezina et. al 1974)
DRBC/NPS218	Smithfield Access (Historic DRBC/NPS Biomonitoring Site)
DEL220	PA side of Poxono Island (Brezina et. al 1974)
DRBC/NPS5	Bushkill Access, NJ, across from access area. (Brezina et. al 1974)
DEL237	Dingman's Access at Dingman's Ferry, PA
DEL243	Opposite Minisink Island, 3.0 miles downstream from Milford, PA
DRBC/NPS461	Across from and upstream of Milford Access Area, NJ side.
DEL251	2.0 miles downstream of Matamoras-Port Jervis bridge
Through Upper Delaware SRR (Upper Delaware)	
DEL258	3.0 miles upstream of Port Jervis, NY
DEL273	Barryville, NY, access area
DEL278	0.5 miles downstream from Lackawaxen access area
DEL289	0.5 miles downstream of Narrowsburg access area
DEL303	0.5 miles downstream of Callicoon Access Area
DEL311	Hankins Access Area opposite Hankins, NY
DRBC/NPS24	Buckingham Access Area, PA
DRBC/NPS89	East Branch Delaware River at Hancock, NY under Rt 97 bridge
DRBC/NPS90	West Branch Delaware River at Hancock, NY under Rt 191 bridge

Table 6. Delaware River & Tributary Historic Biomonitoring Sites, 1980's-1990's.

Some sites may need to be revisited for historic comparisons. July-September sampling period)

Name	River Mile	County
Middle Delaware (through Delaware Water Gap National Recreation Area)		
Delaware River @ Kittatinny Access, NJ	211.58	Sussex, NJ
Delaware River & Brodhead Creek @ Rt. 402 bridge, PA	212.68	Monroe, PA
Cherry Cr. near Rt. 80 bridge, PA	212.69	Monroe, PA
Marshalls Cr. In Minisink Hills at bridge, PA	212.70	Monroe, PA
Delaware River & Shawnee Creek @ Shawnee Resort, PA	214.40	Monroe, PA
Delaware River @ Smithfield Access Area, PA	218.36	Monroe, PA
Delaware River & Flatbrook @ DEWA bdy, NJ	225.48	Sussex, NJ
Delaware River & Bushkill Creek @ DWGNRA boundary, PA	227.10	Monroe/Pike, PA
Delaware River @ Milford Beach vicinity, PA	246.38	Pike, PA
Delaware River & Neversink River @ Rt. 6 bridge, NY	254.14	Orange, NY
Upper Delaware (through NPS Upper Delaware Scenic & Recreational River)		
Delaware River & Mongaup River @ Rt. 97 Bridge, NY	261.84	Orange/Sullivan, NY
Delaware River & Lackawaxen River @ Rt. 590 Bridge, PA	278.92	Pike, PA
Delaware River & Callicoon Creek, NY	303.60	Sullivan, NY
Delaware River @ Buckingham Access, PA	325.20	Wayne, PA
West Branch Delaware River @ Rt. 191 Bridge, Hancock, NY	331.90	Wayne, PA - Delaware, NY
East Branch Delaware River @ Rt. 97 Bridge, Hancock, NY	332.00	Delaware, NY
East Branch Delaware River below Pepacton Reservoir, NY		Delaware, NY
West Branch Delaware River below Cannonsville Reservoir		Delaware, NY

D. Sampling and Analytical Procedures for Baseline Parameters (see Table 1).

The following summarizes methods for each parameter listed in Table 1. Detailed field and laboratory procedures have been adopted from the DRBC/NPS Cooperative Water Quality Monitoring Program Manual (D.J. Kratzer, 1996) and from Standard Methods for the Examination of Water and Wastewater, 20th Edition (1998).

New Jersey Analytical Laboratories of Hopewell, NJ, a New Jersey state-certified laboratory, was hired to analyze most constituents listed in Table 1. DRBC will field-monitor air and water temperature, dissolved oxygen, pH, and conductivity using meters. All other parameters listed in Table 1 will be collected and preserved as recommended in Standard Methods for the Examination of Water and Wastewater, 20th Edition (1998), and delivered within holding time requirements by courier to the laboratory for analysis.

Discharge is measured using an incremental velocity-area method (Wahl et al. 1995) using a Gurley pygmy meter and wading rod. Along a cross-section, at least 20 depth and current velocity measurements are taken to calculate incremental flow. Velocity measurements are taken at 0.6 depth in streams less than 2 feet, and at 0.2 and 0.8 depth and averaged in streams more than 2 feet deep. A cross-section is established at each of the 17 Lower Delaware tributaries listed in Table 2, where flow rating curves are being developed during the 5 year period while existing water quality is being defined. Reference marks are placed on selected bridges so that each time a water quality sample is taken, a water surface elevation is recorded using a fiberglass tape with 0.01 ft increments. It is anticipated that at least five discharge measurements taken under varying flow conditions will be required to developed flow rating curves. These will be related to channel cross-sectional area and water surface elevations for calculation of loading rates of chemical constituents.

Air temperature is measured using analytical thermometers and the YSI52 dissolved oxygen meters. Water temperature is measured in-stream with thermosensing (-10° to 110° C) electronic probes in the DO and conductivity meters, and checked weekly against analytical thermometers.

Dissolved oxygen (DO) is sampled using titrametric and electronic-probe techniques. Routine monitoring is conducted using a YSI (Yellow Springs Instruments) Model 52 dissolved oxygen / temperature meter. The meter is air calibrated before each analysis and checked daily against the Winkler titration method, which is also used as backup to the YSI meter. For Winkler titrations, water samples are collected using glass-stoppered 300 ml BOD bottles for surface samples and a Kemmerer-type sampler for subsurface or boat samples. D.O. is determined immediately using the Azide Modification (or Winkler) Method (Standard Methods 20th Ed., p. 4-131). Reagents used in the determination are purchased pre-mixed and in powder pillow form from Hach Co.

Conductivity is measured in-stream using a YSI Conductivity meter. Calibrations are performed weekly using a 84 μmhos/cm standard solution.

pH is sampled in-stream using an IQ 120™ waterproof meter. The IQ 120 meter is field-calibrated three to four times daily (at Delaware River bridges, as a guideline) using a pH 7 standard solution.

The following chemical parameters will be analyzed by a private laboratory: Hardness, Alkalinity, Turbidity, Chlorides, Chlorophyll a, Nitrate + Nitrite Nitrogen, Ammonia Nitrogen, Total Kjeldahl Nitrogen (TKN), Total Phosphorus, Dissolved Orthophosphate, Total Suspended Solids (TSS), and Total Dissolved Solids (TDS). All will be analyzed by methods described in Standard Methods for the Examination of Water and Wastewater, 20th Edition (1998), or EPA's Methods for Chemical Analysis of Water and Wastes (1983, document number EPA-600/4-79-020) under the certified laboratory's QA/QC procedures. Samples will be collected by DRBC and transported via courier to the laboratory, logistically meeting the most stringent holding time requirement for bacterial samples. Methods and lower reporting limits for chemical constituents are listed in Table 8.

TABLE 7. Lower Delaware Monitoring Program: Desired Analytical Methods

				Number of Sites					
Parameter	Desired Method	Desired Lower Reporting Limit (LRL)	Maximum Holding Time	WQ1 (Tues)	WQ2 (Wed)	WQ3 (Thurs)	Total Sites per Survey	Number of Surveys	Total Samples per Year
Fecal Coliform (#/100ml)	SM 9222 D	n/a	6 hr	16	15	14	45	10	450
Enterococcus (#/100ml)	SM 9230 C	n/a	6 hr	16	15	14	45	10	450
Hardness, Total (mg/l CaCO3)	EPA 130	1 mg/l	7d	16	15	14	45	10	450
Turbidity (NTU)	EPA 180.1	1	24 hr	16	15	14	45	10	450
Alkalinity, Total (mg/l as CaCO3)	EPA 310	1	24 hr	16	15	14	45	10	450
Chlorides (mg/l)	EPA 325.3	1	7d	16	15	14	45	10	450
Phosphorus, Total (mg/l as P)	EPA 365.1	.005 mg/l	7d (acid, 4C)	16	15	14	45	10	450
Orthophosphate (mg/l PO4 as P)	EPA 365.1	.005 mg/l	7d (acid, 4C)	16	15	14	45	10	450
Ammonia Nitrogen (mg/l NH3 as N)	EPA 350	0.1	7d (acid, 4C)	16	15	14	45	10	450
Nitrate-Nitrite Nitrogen (mg/l as N)	EPA 353.2,.3	0.05	7d (acid, 4C)	16	15	14	45	10	450
Total Kjeldahl Nitrogen (mg/l TKN)	EPA 351.2	0.1	7d (acid, 4C)	16	15	14	45	10	450
Total Suspended Solids (mg/l)	EPA 160.2	4	24 hr	16	15	14	45	10	450
Total Dissolved Solids (mg/l)	EPA 160.1	10	24 hr	16	15	14	45	10	450
Chlorophyll A (mg/m3)	SM 10200 H	0.001	24 hr	6	5	6	17	10	170
Not Sampled 2001 due to funding shortage. Add in future seasons.									
BOD 5-Day (mg/l)	EPA 405.1	2	*	34				10	340
Total Organic Carbon (mg/l)	EPA 415	1	*	45				10	450
Dissolved Organic Carbon (mg/l)	EPA 415	1	*	45				10	450

Methods:
SM stands for Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1998.
EPA stands for US Environmental Protection Agency Methods and Guidance for Analysis of Water, CD-ROM v. 2.0, 1999.

Bacterial Monitoring: Fecal coliform and Enterococcus samples are collected in sterile plastic bottles. Sample bottles are placed in an iced cooler. Samples are transported to the laboratory within 6 hours after collection. If a sample holding time exceeds the 6-hour maximum time limit, it will be referenced in STORET. Samples are immediately set-up after transport to a private state-certified laboratory, where analyses will be conducted using the membrane filtration methods outlined for fecal coliforms and enterococci (Standard Methods 9222 and 9230).

Habitat Assessments of wadeable tributaries will be performed using Rapid Bioassessment Protocol

(RBP) procedures for high-gradient streams (Barbour et al. 1999). Delaware River habitat assessments will be conducted using either a large river modification of RBP procedures, or habitat assessment procedures developed by the U.S. Geological Survey for the National Water Quality Assessment Program (NAWQA), which directly address large river habitat (Cuffney et al. 1993; Fitzpatrick et al. 1998).

Benthic Macroinvertebrates (Wadeable Tributary sites): Riffles of wadeable tributaries will be sampled as necessary using a rectangular dip net (500μm mesh) by the single habitat benthic macroinvertebrate procedure described in the Rapid Bioassessment Protocols (1999). All tributaries except for the Assunpink Creek, Lehigh River, and Paulins Kill would be sampled according to this procedure. Collection proceeds within a 100-m reach, compositing at least 2 m^2 area of cobble substrate from riffles and runs representing different velocities. Samples are placed in a white plastic pan and assessed on-site using a procedure adapted from that used by New York State DEC (Bode et al. 1996). Examination of macroinvertebrates on-site consists of placing sorted organisms in a pan with several compartments and applying criteria for determination of non-impact. Failure of any one of the following criteria establishes possible impact, and relative impact is judged in a 10-point scoring system (score of 5 or less indicates severe impact, triggering further investigation):

1. Mayflies must be present and numerous; at least three species must be present.
   Scoring: 0 = rare, tolerant only; 1 = up to 3 taxa, mostly tolerant; 2 = rich, abundant, intolerant.
2. Stoneflies must be present.
   Scoring: 0 = not present; 1 = present, not rich or abundant; 2 = rich and abundant.
3. Caddisflies must be present, but not more abundant than mayflies.
   Scoring: 0 = rare, tolerant forms; 1 = present, abundance>mayflies; 2 = rich, abundant, intolerant.
4. Beetles must be present.
   Scoring: 0 = not present; 1 = rare; 2 = abundant Psephenidae & Elmidae at minimum.
5. Aquatic worms must be absent or sparse.
   Scoring: 0 = present, no Stoneflies; 1 = present, Stoneflies present; 2 = none present.

Samples preserved for further investigation will be processed under NJDEP and PADEP protocols for comparison with state criteria. 10% of samples held by the end of the sampling season (if any) will be sent to another laboratory for quality control of identification and sorting efficiency. We are presently investigating laboratories to fulfill the QA/QC function. This portion of the monitoring program is dependent upon allocation of staff time, and has not been set as a priority activity.

Benthic Macroinvertebrates (Delaware River Survey):

Macroinvertebrates will be sampled at approximately 33 riffles along the Delaware River from above Hancock, NY to Trenton, NJ. Many sites correspond with Delaware River sites chosen by NJDEP and PADER's 1974 joint study of Delaware River Basin water quality (Brezina et al. 1976). During an index period of August and September 2001, three replicates will be taken from each location. Flow conditions must be low enough to allow safe access to Lower Delaware sites (generally less than 6,000 cfs at Trenton). Benthic macroinvertebrates will be sampled by two people using a custom made, semi-quantitative kick net designed by Robert Limbeck of DRBC with Wildlife Supply Company (Wildco). Dimensions are 30"W x 24"H, with a 500μm mesh size, and a 24 x 24" (0.37 square meter) stream bottom isolation frame to delineate the area to be disturbed. Three replicates and a large sampling area ensure that variability attributable to patchy distribution of macroinvertebrates is reduced. Consistency of substrate size, canopy cover, and flow velocity will be measured so that variability attributable to these factors is reduced. Samples will be preserved in 70% Ethanol and transported back to the laboratory for sorting and identification. Rapid Bioassessment Protocol (Barbour et al. 1999) sorting techniques will be applied, and 200-organism subsamples will be used for development of metrics.

In the laboratory, macroinvertebrates (200-organism subsamples) will be analyzed to genus, and metrics relating to diversity, richness, equitability, pollution tolerance, and functional feeding habit will be calculated and tested for sensitivity to water quality changes. Those deemed most sensitive will be combined into a benthic index scoring system. Sites will be compared to one another along the longitudinal gradient of the river, and similar reaches may be assigned preliminary numeric biocriteria. Metrics will be calculated at the genus level (chironomids to family), and recalculated for comparison with assessment methods established at the family level for PADEP and NJDEP biomonitoring programs. Each sample will then be picked completely and retained for further identification to species, so that a species reference list for the reach may be compiled, supplementing reference lists obtained by DRBC from each state's biological monitoring program. DRBC will investigate laboratories qualified to verify identification and sorting efficiency by program staff. Ten percent (10%) of all samples will be sent out for QA/QC checks.

Habitat information will be recorded along with each benthic sample collected, including at minimum a reach map, pebble count, velocity profile of the river cross section, channel characteristics such as width, depth, and delineation of microhabitats in the vicinity of the sampling site. Existing protocols will be adapted to the large river setting, including RBP High Gradient (Barbour et al. 1999) and NAWQA (Cuffney et. al 1993; Fitzpatrick et al. 1998).

E. Reports and Forms

The program staff is required to maintain a log of activities. Notebooks and common computer files accessible to all study participants are used to record observations (weather, etc.), to describe sampling station locations, and to present results. Several data record/analyses sheets were developed or adopted from other agencies for recording results. These are used routinely for water quality, flow, habitat, macroinvertebrate, and stream channel condition studies (See Exhibits 2,3 and 4). QA reporting forms have been developed for use by staff for QA recording activities (see Exhibit 5). All forms contained in the Rapid Bioassessment Protocols (Barbour et. al 1999) and USGS NAWQA Protocols (Cuffney et. al 1993; Fitzpatrick et. al 1998) are copied directly from those documents for field use.

V. Sample Custody

All samples will be logged according to chain of custody procedures (see form, Exhibit 5). The program manager is responsible for record-keeping, including preparation of sample labels, laboratory logging procedures and maintenance of reports as described above. In cases where a laboratory is contracted for analyses, field personnel follow the contract laboratory’s sample custody procedures.

VI. Data Reduction, Validation and Reporting

Data will be entered into STORET as soon as practical after internal review. Dissolved oxygen concentrations and water temperatures are converted to percent dissolved oxygen saturation. River sample results are expressed as reach-wide geometric means, site-specific geometric means, and compared with stream quality objectives and/or state criteria as applicable. River data are plotted by river mile, and grouped according to common geographic properties. Data are analyzed using Microsoft EXCEL spreadsheets, SAS Institute's SAS statistical analysis scripts, and the STORET ORACLE database management system. GIS is increasingly used for program planning and analysis, employing ArcView and Arc-Info by ESRI. Chemical data are validated in the following manner:

Holding Times (see Table 8) and Detection Limits: If holding times and/or preservation for any parameters are not met, all data, if to be recorded in STORET, will be qualified with a "Q" remark code (see Table 9 for STORET remark codes). The sampling schedule for the program is designed so that adequate time is provided for sample collection and laboratory preparation. Should a gross holding time violation occur, the samples would be discarded. Should results fall below the instrument detection limit (IDL), the results will be remarked with a "U"; those results above the IDL but below the quantitation limit will be remarked as "J."

Table 8. Holding Times for Lower Delaware Monitoring Program Constituents

Parameter	**Lab Preparation**	**Field Prep.**	**Holding Time**
DRBC field parameters (record all calibration results in lab notebook)			
Dissolved Oxygen (meter)	Calibrate vs. 3 Winklers daily	Air calibrate	None (field meas.)
Dissolved Oxygen (Winkler)	none	Acidify	8 hrs (titrate same day)
Air Temperature (DO meter)	check vs. thermometer daily	Stabilize meter	None (field meas.)
Air Temperature (thermometer)	annual vs. Nat. Bur. Stds. therm.	None	None (field meas.)
Water Temperature (DO meter)	check vs. thermometer daily	Stabilize meter	None (field meas.)
Water Temperature (Cond. meter)	check vs thermometer daily	None	None (field meas.)
Water Temperature (thermometer)	annual vs. Nat. Bur. Stds. therm	None	None (field meas.)
Conductivity (YSI meter)	calibrate vs. 84 μmhos/cm daily	Rinse DIUF	None (field meas.)
pH (Oakton pH Testr2 meter)	calibrate vs. std. pH 4, 7, 10 daily	Rinse DIUF	None (field meas.)
pH (IQ 120 meter)	calibrate vs. std. pH 7 4x/d	Rinse DIUF	None (field meas.)
DRBC-collected constituents analyzed by contract laboratory (all samples require chain of custody)			
Hardness (Total)	label acid-washed 200 ml bottle	HNO_3 to pH<2	7d
Chloride	label acid-washed 200 ml bottle	None	7d
Alkalinity (Total)	label acid-washed 200 ml bottle	Ice, Refrig.	24h
Turbidity	label acid-washed 200 ml bottle	Foil, Ice, Refrig.	24h
Fecal Coliform	label sterilized bottles	Ice	6 h from 1st sample
Enterococcus	label sterilized bottles	Ice	6 h from 1st sample
Nitrate + Nitrite	label 200 ml bottles	Ice, Acid	7d
Ammonia N	label, acidify plastic bottle	Ice, Acid	7d
Total Phosphorus	label, acidify plastic bottle	Ice, Acid	7d
Dissolved Orthophosphate	label acid-washed 200 ml bottle	Ice, Acid	24h
Chlorophyll a	label BOD bottles	Dark Bottle, Ice	24h
Total Kjeldahl Nitrogen (TKN)	label 500 ml bottles	Ice, Acid	7d
Total Suspended Solids (TSS)	label 200 ml bottles	Ice	24h
Total Dissolved Solids (TDS)	label 200 ml bottles	Ice	24h

Blanks: Blank results will be assessed to detect the existence and magnitude of contamination. The criteria for evaluation of blanks apply to any blank associated with the samples. If problems with any blank exist, all data associated with that blank must be carefully evaluated to learn if there is an inherent variability in the data. When evaluating blanks, the source will be considered. Blanks can be categorized into blanks generated in the field (equipment rinse and field blanks) and blanks generated in the laboratory (method blanks). The criteria for evaluation of blanks generated in the laboratory apply to any blank associated with a set of samples. If the highest level of contamination is found in a field blank, all samples associated with that field blank should be qualified as noted: Should a blank contamination be observed, sample concentrations will be remarked with "B" code.

Table 9: Remark Codes Used for STORET Data Validation

A	Value reported is the mean of two or more determinations.
B	Results based upon colony counts outside the acceptable range.
C	Value calculated.
D	Indicates field measurement.
E	Indicates extra samples taken at composite sample stations.
F	In the case of species, F indicates Female sex.
G	Value reported is the maximum of two or more determinations.
H	Value based on field kit determination, results may not be accurate.
J	Estimated value; value not accurate.
K	Actual value is known to be less than the value given.
L	Actual value is known to be greater than the value given.
M	Presence of material verified but not quantified. In the case of temperature or oxygen reduction potential; M indicates negative value. In the case of species, M indicates Male sex.
N	Presumptive evidence of presence of material.
O	Sampled, but analysis lost or not performed.
S	Laboratory test.
T	Value reported is less than criteria of detection.
U	Indicates material was analyzed but not detected. In case of species, U indicates Undetermined sex.
W	Value observed is less than lowest value reportable under “T” code.
Z	Too many colonies were present to count (TNTC), numeric value is filtration volume.

Duplicates: Ten percent (10%) of samples analyzed by the contract laboratory will be duplicated. Dilutions will be run to determine the accuracy limits of analytical equipment. Reporting forms are presented in Exhibit 5.

Matrix Spike Samples: Matrix spikes are not done since the spikes would likely exceed the concentration of any sample collected by this program.

Laboratory Control Samples (LCS) will be prepared from a standard solution and analyzed in duplicate for each sample batch.

Field Blanks: These will be prepared using deionized water added in the field (5% of samples).

Method Blanks: Prepared in the laboratory using deionized water.

VII. Internal And External Quality Control Checks

Fecal and enterococcal bacteria test procedures will be checked by the contract laboratory according to their quality assurance methods. A field blank for chemical analyses will be collected at a frequency of one per twenty samples. Field blanks will be prepared by pouring analyte-free water into a clean sample container in the field. The preservation and analysis of field blanks will be the same as other samples. Field replicates will be collected at a frequency of one per ten samples. Laboratory control samples are analyzed in duplicate at a frequency of one per twenty samples. A method blank will be analyzed at a frequency of one per twenty samples. The concentration of the method blank should be less than the project required detection limit. The QC limit for laboratory duplicates must fall within a range of ± 20% of the required detection limit.

Analytical capabilities for all non-biological parameters (pH, water temperature, dissolved oxygen and chemical parameters) will be checked against each other by sample splitting and analysis. Standard solutions will be used by the Quality Assurance Officer to conduct additional testing of analytical precision and accuracy.

VIII. Performance and System Audits

Most elements of this section have been described previously. Before the initiation of the sampling season, the manager prepares the program by checking all equipment, making repairs, and by purchasing equipment and chemicals. The QA Officer performs an audit of the contract laboratory prior to commencement of the program. The program manager and the QA officer observe field and lab procedures, checking data including quality control checks and other activities related to program administration.

The program manager and the QA officer will conduct field audits to evaluate sampling technique, sample handling, and preservation to insure representative results. Personnel safety measures are highlighted, and all relevant personnel are required to read and understand the DRBC Field Safety Manual. The laboratory audits review analytical, sample preparation, and data reporting procedures. Also, laboratory cleanliness and safety are emphasized. DRBC's laboratory must comply with the New Jersey Right-to-Know Act, and all chemical materials must be properly stored and labeled.

IX. Preventive Maintenance and Calibration

Preventive maintenance activities are conducted prior to the sampling season. Spare parts are maintained for sampling equipment. DRBC maintains extra nets and sampling devices. The major preventive maintenance activity of the LDCMP is assuring that sufficient media, reagents, preservatives, filters, etc., are purchased before the initiation of the program each year.

Calibration consists of checking the accuracy of temperature related equipment: thermometers and YSI temperature sensors; and analytical equipment such as dissolved oxygen meters, analytical balances, a YSI photometer, conductivity meters, and pH testers. At the beginning of the sampling program thermometers will be checked by comparing thermometers against each other and by calibration against a certified National Bureau of Standards thermometer. Dissolved oxygen meter calibrations are checked using Winkler titration. Analytical balance calibrations are checked with reference weights. Calibration checks of the conductivity meters and pH testers are conducted using commercial standard solutions. Staff calibrates the equipment via written instructions from the project director. Instructions are included as part of a manual prepared for the summer staff.

X. Assessment of Data Precision, Accuracy and Completeness

Elements of this section have been described previously. The specific routine procedures are:

- When applicable, the estimated precision of macroinvertebrate analyses will be evaluated by examining reconstituted samples and comparing the results with original findings (one per ten samples).
- The precision and accuracy of selected water chemistry tests will be examined by using standard solutions and by comparing the results of parallel test findings. The following equations to be used to calculate precision, accuracy and completeness:

Precision

$$RPD = \frac{(C_1 - C_2)}{(C_1 + C_2) / 2} \times 100$$

RPD = relative percent difference
C1 = larger of the two observed values
C2 = smaller of the two observed values

Accuracy: For measurements where a standard reference material or separate standard solution is used.

$$\%R = 100 \times \frac{C_m}{C_{rm}}$$

%R = percent recovery
Cm = measured concentration of standard reference material
Crm = actual concentration of standard reference material

Completeness

$$\%C = 100 \times \frac{V}{n}$$

%C = percent completeness
V = number of measurements judged valid
n = total number of measurements necessary to achieve a specified statistical level of confidence in decision making.

Equipment: thermometers, dissolved oxygen meters, balances, pH meters and conductivity meters are calibrated before use. Where it is possible to analyze parameters by more than one method (e.g., Winkler dissolved oxygen versus Hach kit and probe) parallel results are compared.

XI. Corrective Actions

Corrective actions, as previously discussed, are initiated during routine internal and external quality control checks. Corrective actions are to be ordered by the Quality Assurance Officer, after consultation with the Project Manager, when periodic quality assurance inspections turn up unacceptable variations in data sets obtained during implementation of quality control procedures. If the problems noted by the Quality Assurance Officer are not corrected to his/her satisfaction, a memorandum or report will be prepared by the Quality Assurance Officer and sent to all staff involved in planning and implementation of the program.

XII. Quality Assurance Records to Management

The Project Manager will report to the Quality Assurance Officer for inspection and application of performance and system audits. Reports will present the results of internal and external quality checks, corrective actions taken, and analytical results. The reporting procedures will consist of the submittal of logbooks and forms as shown in Exhibit 6.

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Exhibit 1:

Organization Chart

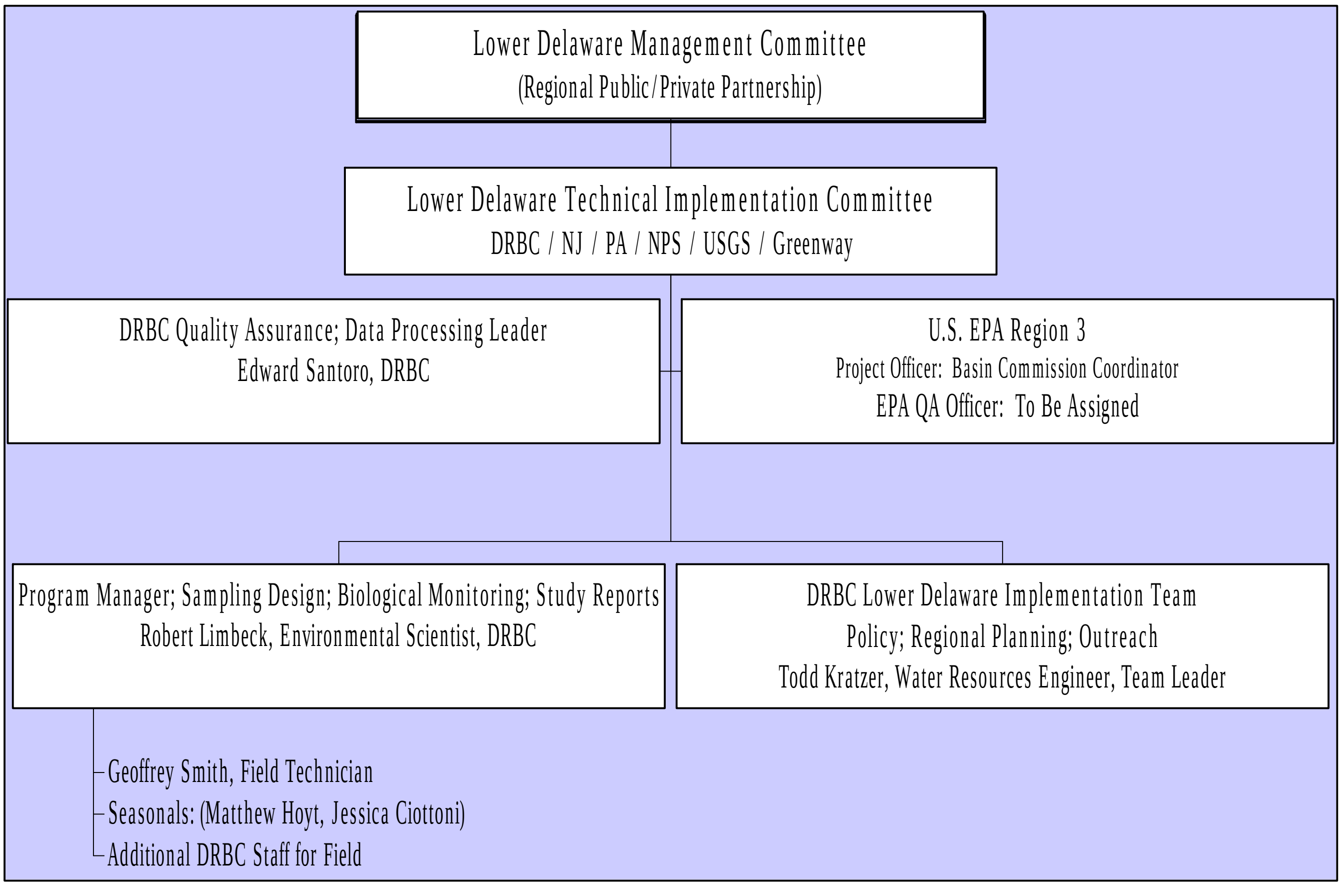
Lower Delaware Management Committee
(Regional Public/Private Partnership)
Lower Delaware Technical Implementation Committee
DRBC / NJ / PA / NPS / USGS / Greenway
DRBC Quality Assurance; Data Processing Leader
Edward Santoro, DRBC
U.S. EPA Region 3
Project Officer: Basin Commission Coordinator
EPA QA Officer: To Be Assigned
Program Manager; Sampling Design; Biological Monitoring; Study Reports
Robert Limbeck, Environmental Scientist, DRBC
DRBC Lower Delaware Implementation Team
Policy; Regional Planning; Outreach
Todd Kratzer, Water Resources Engineer, Team Leader
Geoffrey Smith, Field Technician
Seasonals: (Matthew Hoyt, Jessica Ciottoni)
Additional DRBC Staff for Field

Exhibit 2:

Water Quality Monitoring Form

LOWER DELAWARE MONITORING PROGRAM
WATER QUALITY MONITORING FORM

1) River Mile (RM/Trib 1/Trib 2/State) ___ ___ ___.___ ___/ ___.___ ___/ ___.___ ___/ ___ ___

Station Name ____

Station Number DRBC ___ ___ ___ ___ ___ _

2) Date (Yr/Mo/Day) and Time (military) ___ ___ ___ ___/ ___ ___/ ___ ___ ___ ___:___ ___

3) Dissolved Oxygen (mg/l) Method ___________ ___ ___.___

4) Air Temperature (^oC) Method ___________ ___ ___.___

5) Water Temperature (^oC) Method ___________ ___ ___.___

6) Specific Conductance (mmhos/cm) Method ___________ ___ ___ ___

DEWA: use temp compensation equation {[(25 - _______)(0.02)(_______)] - (_______)}

H2O temp. actual reading actual reading

7) pH Method ___________ ___ ___.___

8) Stream Gage (ft. hundredths or in. 1/16) ( ) + ( ) = ___ ___ ___.___ ___

measurement leader length

9) Weather Conditions ____

____

10) Dates of Last Rain ___ ___ ___ ___/ ___ ___/ ___ ___ ___ ___ ___ ___/ ___ ___/ ___ ___

11) Comments on Water Conditions/Sampling Site ____

____

12) Were macroinvertebrates sampled? ______________Yes ______________No

13) Was RBP Habitat Assessed? ______________Yes ______________No

14) Sampled by ____________________ Agency (DEWA, UPDE, or DRBC) ___ ___ ___ ___

15) Nitrate / Phosphate / Ammonia sample volume ___ ___ ___ ___ **ml** Collection Time ___ ___ : ___ ___

16) Turbidity / Alkalinity sample volume (ml) ___ ___ ___ ___ Collection Time ___ ___:___ ___

17) Hardness / Chlorides sample volume (ml) ___ ___ ___ ___ Collection Time ___ ___:___ ___

18) Check if samples collected for contract lab: FC ___ Entero ___ Chl A ___ TKN ___ TSS ___ TDS ___

Exhibit 3:

Streamflow Data Sheet

Stream Gage Data Sheet

Streamflow Conversion Chart

SCENIC RIVERS MONITORING PROGRAM
STREAMFLOW DATA SHEET

River Mile (RM/Trib 1/Trib 2/State) ___ ___ ___.___ ___/ ___.___ ___/ ___.___ ___/ ___ ___

Station Name ____

Station Number DRBC/NPS ___ ___ ___ ___

Date (Yr/Mo/Day) ___ ___/ ___ ___/ ___ ___ Time (HHMM) ___ ___:___ ___

Party ____________________________ Agency ___ ___ ___ ___

Location of Test Site From Gage Station ______________________________

Weather Conditions ______________________________

Dates of Last Rains ___ ___/ ___ ___/ ___ ___ ___ ___/ ___ ___/ ___ ___

Water Temperature ______________

Air Temperature ______________

Gage Read-ings		Time	Tape Reading	Leader Length	Total Gage
	Before		+		=
	After		+		=

Gage Height at Zero Flow ______________

Type of Meter ______________

Spin Test in Seconds ______________

Tape Reading at Near Bank ______________

Tape Reading at Far Bank ______________

Total Width of Stream ______________

Interval Width Chosen ______________

Total Number of Intervals ______________ (minimum 15)

Flow Width = (total width) - (zero flow intervals) ______________

Flow Area = Sum (incremental width X incremental depth) ______________

Average Depth = flow area / flow width ______________

Average Velocity = total discharge / total flow area ______________

CONVERSIONS

inches	feet
1 =	0.083
2 =	0.167
3 =	0.250
4 =	0.333
5 =	0.417
6 =	0.500

inches	feet
7 =	0.583
8 =	0.667
9 =	0.750
10 =	0.833
11 =	0.917
12 =	1.000

inches	feet
1/16 =	0.0052
1/8 =	0.0104
1/4 =	0.0208
1/2 =	0.0417

Inter-val #	Tape read-ing [1]	Dist. from stream edge [2]	Interval Width (tenths)	Interval Depth (tenths)	Observ. Depth [3] (tenths)	Revolu-tions [4]	Time (sec.)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							

Calculations completed by ______________________ Checked by ______________

Remarks:

[1]Tape reading is the actual reading that the tape shows at the edge of the stream (where testing begins), and the actual reading where testing is completed is at the opposite edge, and all interval mid-points in between.

[2]The stream edge for our purposes is the point where the water presently meets the bank of the stream. Choose one edge to begin measurement and the opposite edge to terminate, giving the streams present total width.

[3]The Observation Depth is 0.6 of the depth if the depth is less than 2'. If the depth is 2' or greater, measurements must be taken at 0.2 and 0.8 of the depth. The two velocities will be averaged, then multiplied by the Interval Area to give the Interval Discharge.

[4]Start the stopwatch on a click but do not count that click as a revolution.

STREAM GAGE DATA SHEET

STATION NAME	DATE	TIME	GAGE HEIGHT	DISCHARGE	FLOW AREA	FLOW WIDTH	RECORDER (S)

Actual Rating Limits: 0.25 to 3.0 feet per second EQUATION: V = 0.977 R + 0.028 Pygmy Standard Rating

R = Revolutions / Seconds

Seconds	VELOCITY IN FEET PER SECOND Revolutions														
	3	5	7	10	15	20	25	30	40	50	60	80	100	150	200
40	.101	.150	.199	.272	.394	.516	.639	.761	1.00	1.25	1.49	1.98	2.47	3.69	4.91
41	.099	.147	.195	.266	.385	.505	.624	.743	.981	1.22	1.46	1.93	2.41	3.60	4.79
42	.098	.144	.191	.261	.377	.493	.610	.726	.958	1.19	1.42	1.89	2.35	3.52	4.68
43	.096	.142	.187	.255	.369	.482	.596	.710	.937	1.16	1.39	1.85	2.30	3.44	4.57
44	.095	.139	.183	.250	.361	.472	.583	.694	.916	1.14	1.36	1.80	2.25	3.36	4.47
45	.093	.137	.180	.245	.354	.462	.571	.679	.896	1.11	1.33	1.76	2.20	3.28	4.37
46	.092	.134	.177	.240	.347	.453	.559	.665	.878	1.09	1.30	1.73	2.15	3.21	4.28
47	.090	.132	.174	.236	.340	.444	.548	.652	.859	1.07	1.28	1.69	2.11	3.15	4.19
48	.089	.130	.170	.232	.333	.435	.537	.639	.842	1.05	1.25	1.66	2.06	3.08	4.10
49	.088	.128	.168	.227	.327	.427	.526	.626	.826	1.02	1.22	1.62	2.02	3.02	4.02
50	.087	.126	.165	.223	.321	.419	.516	.614	.810	1.00	1.20	1.59	1.98	2.96	3.94
51	.085	.124	.162	.220	.315	.411	.507	.603	.794	.986	1.18	1.56	1.94	2.90	3.85
52	.084	.122	.160	.216	.310	.404	.498	.592	.780	.967	1.16	1.53	1.91	2.85	3.79
53	.083	.120	.157	.212	.305	.397	.489	.581	.765	.950	1.13	1.50	1.87	2.79	3.71
54	.082	.118	.155	.209	.299	.390	.480	.571	.752	.933	1.11	1.48	1.84	2.74	3.65
55	.081	.117	.152	.206	.294	.383	.472	.561	.739	.916	1.09	1.45	1.80	2.69	3.58
56	.080	.115	.150	.202	.290	.377	.464	.551	.726	.900	1.07	1.42	1.77	2.64	3.52
57	.079	.114	.148	.199	.285	.371	.457	.542	.714	.885	1.06	1.40	1.74	2.60	3.45
58	.079	.112	.146	.196	.281	.365	.449	.533	.702	.870	1.04	1.38	1.71	2.55	3.40
59	.078	.111	.144	.194	.276	.359	.442	.525	.690	.856	1.02	1.35	1.68	2.51	3.34
60	.077	.109	.142	.191	.272	.354	.435	.516	.679	.842	1.00	1.33	1.66	2.47	3.28
61	.076	.108	.140	.188	.268	.348	.428	.508	.669	.829	.989	1.31	1.63	2.43	3.23
62	.075	.107	.138	.186	.264	.343	.422	.501	.658	.816	.973	1.29	1.60	2.39	3.18
63	.075	.106	.137	.183	.261	.338	.416	.493	.648	.803	.958	1.27	1.58	2.35	3.13
64	.074	.104	.135	.181	.258	.333	.410	.486	.639	.791	.944	1.25	1.55	2.32	3.08
65	.073	.103	.133	.178	.253	.329	.404	.479	.629	.780	.930	1.23	1.53	2.28	3.03
66	.072	.102	.132	.176	.250	.324	.398	.472	.620	.768	.916	1.21	1.15	2.25	2.99
67	.072	.101	.130	.174	.247	.320	.393	.465	.611	.757	.903	1.19	1.49	2.22	2.94
68	.071	.100	.129	.172	.244	.315	.387	.459	.603	.746	.890	1.18	1.46	2.18	2.90
69	.070	.990	.127	.170	.240	.311	.382	.453	.594	.736	.878	1.16	1.44	2.15	2.85
70	.070	.098	.126	.168	.237	.307	.377	.447	.586	.726	.856	1.14	1.42	2.12	2.82
	3	5	7	10	15	20	25	30	40	50	60	80	100	150	200

Flow Area = Sum (incremental width X incremental depth ______

Average Depth = flow area / flow width ______

Average Velocity = total discharge / total ______

CONVERSIONS

Eng. (inch)	Decimal
1	0.083
2	0.167
3	0.250
4	0.333
5	0.417
6	0.500

Eng. (inch)	Decimal
7	0.583
8	0.667
9	0.750
10	0.833
11	0.917
12	1.00

Eng. (inch)	Decimal
1/16	0.0052
1/8	0.0104
1/4	0.0208
1/2	0.0417

Exhibit 4:

Field-Level Macroinvertebrate Assessment Form (after NYSDEC 1996)

Delaware River Basin Commission
Lower Delaware Monitoring Program

Macroinvertebrate Field Assessment Sheet

Stream / Station Location ____

____

Date ________________ Time ______________________ Collectors _________________________

PHYSICAL AND CHEMICAL PHOTOGRAPH Nos. (describe on back)_________________

DEPTH (FT) ________________ AIR TEMPERATURE (°C) ___________

WIDTH (FT) ________________ WATER TEMPERATURE (°C) ________

CURRENT (FT/SEC) _________ DISSOLVED OXYGEN (mg/l) ________

CANOPY (%) _______________ pH _______________________________

EMBEDDEDNESS (%) _______ CONDUCTIVITY (µmhos/cm) ________

SUBSTRATE (%) bedrock_____ cobble _______ gravel ______ sand_______ silt__________

AQUATIC VEGETATION (check if present, identify or bring sample back to lab for identification)

algae (suspended) ______ algae (filamentous) _____ diatoms (on rocks) ______ macrophytes _______

List species ____

TYPE OF SAMPLE (check)	OCCURRENCE OF MACROINVERTEBRATES (Abundant, Common, Present, Rare)		
Hester-Dendy _______	Ephemeroptera_______	Chironomidae________	Plecoptera____________
600µ d-frame net _____	Simuliidae___________	Trichoptera__________	Decapoda_____________
Surber _______________	Coleoptera___________	Gammaridae_________	Megaloptera___________
Big River 500µ_______	Mollusca____________	Odonata_____________	Oligochaeta___________
Other (Specify) _______	Other_______________________________________		

FIELD ASSESSMENT OF IMPACT (check): non ____ slight ____ moderate ____ severe ________

abundance of EPT Taxa (Y/N)_______ Dominance of Tolerant Groups (Y/N)___________________

sample abundance (low/high)________ richness (low/high) _______ other ________________

SITE SCREENING CRITERIA (Assign Score, Comments) TOTAL SCORE (0-10) ________

Mayflies (3 or more taxa) ____
(0 = rare, tolerant forms only; 1 = up to 3 taxa, mostly tolerants; 2 = rich, abundant)

Stoneflies (present)____
(0 = none present; 1 = present, not rich or abundant; 2 = rich and abundant)

Caddisflies (should be less abundant than mayflies)_______________________________________
(0 = rare, tolerant forms only; 1 = present, more abundant than mayflies; 2 = rich, abundant, intolerant)

Beetles (present) ____
(0 = none present; 1 = rare; 2 = abundant Elmidae & Psephenidae at minimum)

Worms & Red Chironomid Midges (sparse or absent)_____________________________________
(0 = present, no stoneflies; 1 = present, stoneflies present; 2 = none present)

Exhibit 5:

QC Reporting Forms

SCENIC RIVERS MONITORING PROGRAM
MONTHLY QUALITY ASSURANCE REPORT

Rev. 07/31/95 AJA

This report covers the period _______________________ to _____________________

SUMMARY OF QUALITY ASSURANCE PROJECT PLAN

Bacterial media blanks	one per sampling day
Bacterial replicates w/ same volume	every 10th bacterial sample
Bacterial replicates w/ different volumes	every 30th bacterial sample
Incubator temperatures	checked to thermometer daily whenever samples are being incubated
Conductivity meters	checked to standard solution once per sampling month
pH (Corning)(Lab use only)	checked to two standard solutions each day that it is used (before & after)
pH (Hach test kit)	checked to standard solution once per sampling week
pH (Hanna Tester)	calibrated to pH 7 standard buffer solution each sampling day
LaMotte Colorimeter	checked to at least 2 standard solutions per parameter per sampling month
Colorimetric replicates	every 10th colorimetric sample for each parameter
Dissolved oxygen meters	checked to Winkler titration once per sampling day; change membrane once every two weeks
Temperature (cond. meter or thermometer)	checked to NBS thermometer once per sampling week

This summary represents minimum QA checks: More may be done. For details concerning quality assurance, refer to Quality Assurance Project Plan.

NOTES FOR PERIOD REPORTED:

BACTERIAL MEDIA BLANKS (# colonies per plate) (25 ml is usually filtered)

DATE	AGENCY	NAME	TEST*	COLONY COUNT

BACTERIAL REPLICATES W/ SAME VOLUME (# colonies per plate) (two plates with the same volume are processed, i.e. 50 ml & 50 ml)

DATE	AGENCY	NAME	TEST*	PLATE 1	PLATE 2	DIFFERENCE

*FC = fecal coliform, FS = fecal streptococcus

BACTERIAL REPLICATES W/ DIFFERENT VOLUMES (# colonies per #/ml) (three plates with different volumes are processed, I.e. 50 ml, 25 ml & 10 ml)

DATE	AGENCY	NAME	TEST*	PLATE 1	PLATE 2	PLATE 3
				/ ml	/ ml	/ ml
				/ ml	/ ml	/ ml

*FC = fecal coliform, FS = fecal streptococcus

INCUBATORS (^{o}C) Circle One: DEWA, DRBC@DEWA, DRBC@UPDE, DRBC#805; Circle One: DEWA, DRVC@DEWA, DRBC@UPDE, DRBC#805

DATE	NAME	DESIRED TEMP	ACTUAL TEMP	DIFFER-ENCE

DATE	NAME	DESIRED TEMP	ACTUAL TEMP	DIFFER-ENCE

CONDUCTIVITY (mmhos/cm)

DATE	AGENCY	NAME	METHOD A	VALUE (A)	STANDARD SOLUTION VALUE	DIFFERENCE [A - Standard Soln]
				@ ^{o}C	@ ^{o}C	
				@ ^{o}C	@ ^{o}C	

AUTOCLAVE

DATE	AGENCY	NAME	DESIRED TEMPERATURE	ACTUAL TEMP. REACHED	DIFFERENCE [desired - actual]

pH (Corning pH Meter)

DATE	AGENCY	NAME	VALUE BEFORE	VALUE AFTER	DIFFERENCE [before - after]

pH (Hach Test Kit)

DATE	AGENCY	NAME	VALUE A	STANDARD SOLUTION VALUE	DIFFERENCE [A - Standard Soln]

pH (Hanna Tester)

DATE	AGENCY	NAME	VALUE BEFORE	VALUE AFTER	DIFFERENCE [before - after]

COLORIMETRIC REPLICATES W/ SAME VOLUME

DATE	AGENCY	NAME	PARAMETER	SAMPLE	REPLICATE	DIFFERENCE

COLORIMETER

DATE	AGENCY	NAME	PARAMETER	COLORIMETER VALUE (A)	STANDARD SOLUTION	DIFFERENCE [A - Standard Soln]

DISSOLVED OXYGEN (mg/l)

Dates Membrane Changed: ______________________________

DATE	AGENCY	NAME	METHOD A	VALUE (A)	METHOD B	VALUE (B)	DIFFERENCE [B-A]

WATER TEMPERATURE (^oC)

DATE	AGENCY	NAME	METHOD A	VALUE (A)	METHOD B	VALUE (B)	DIFFERENCE [B-A]

Exhibit 6:

Chain of Custody Record

Lower Delaware Monitoring Program Chain of Custody Record

Page_____ of _____

Project Manager:		Robert L. Limbeck			Agency: Delaware River Basin Commission			
Address & Phone:		PO Box 7360, W. Trenton NJ 08628 609-883-9500 x 230			Project: Lower Delaware Cooperative Monitoring			
Date Collected (YYYYMMDD)	Time Collected (Mil. HHMM)	Site No. Location		# jars	Sample Type (see below)	Preserv-ation (see below)	Collect. Method (Grab / Composite)	Log Number (Seq+)
Sampled by (signature):								
Received by (signature):					Date		Time	
Received by (signature):					Date		Time	
Received by (signature):					Date		Time	
Received by (signature):					Date		Time	
Received by (signature):					Date		Time	

Instructions/Notes: Each Sample Bag Contains:

1 L Unpreserved = N/N; Alk; Ortho; TDS; TSS
500 ml pH<2 H_2SO_4 = TP; NH_3; TKN
120 ml sterilized = Fecal Coliform
120 ml sterilized = Enterococci
120 ml sterilized = E. coli & Total Coliform
120 ml pH<2 HNO_3 = Hardness
1 L Amber unpreserved glass = Chlorophyll a (selected sites)

Instructions:

Record all information concerning samples.
Check log numbers against containers to assure all samples are present, then sign in appropriate spaces.
Keep original Chain-of-Custody Record with samples.
Person relinguishing samples should receive a photocopy of this form.
Notify Project Manager immediately of any damaged or missing samples.

Appendix A

Lower Delaware Monitoring Program 2001

Monitoring Matrix
Master Site List
Driving Directions for Water Quality Runs 1,2,3

Lower Delaware Monitoring Matrix 2001

F = grab sample, analyze in field
G = grab sample, preserve for lab
C = composite sample from PA-Center-NJ channels
S = get ADAPS streamflow data for time of sample
LGR = Water Level Logger installed for all or part of season
BLACKOUT = No Samples

				DRBC Field						Contract Lab Parameters																
Site No	RMI	Sites	DATE/2001	DO (EPA 360.1)	pH (EPA 150.1)	Air temp (EPA 170.1)	Water temp (EPA 170.1)	Gage Ht (ft.01)	Conductivity (EPA 120.1)	Hardness (EPA 130)	Turbidity (EPA 180.1)	Alkalinity (EPA 310)	Chlorophyll a (SM 10400H)	Total P (EPA 365)	Orthophosphate (EPA 365)	Ammonia N (EPA 350)	Nitrate+Nitrite N (EPA 353)	TKN (EPA 351)	Fecal Coliform (SM 9222D)	E. coli & TC (SM 9222D+coliblue)	Enterococcus (SM 9230C)	TSS (EPA 160)	TDS (EPA 160)	BOD 5 Day (EPA 405.1)	Chloride (EPA 325)	
		RUNS 1 THROUGH 10																								
DRBCNJPAC01	134.34	Delaware R @ Calhoun St Bridge, PA-NJ	DAY1 WQ1	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	
DRBCNJPAC02	141.80	Delaware R @ Washington Crossing Br, PA-NJ	DAY1 WQ1	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	
DRBCPA0008	146.30	Pidcock Creek, PA	DAY1 WQ1	F	F	F	F	F	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G	
DRBCNJPAC11	148.70	Delaware River @ Lambertville-New Hope Bridge, PA-NJ	DAY1 WQ1	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	
DRBCNJ0012	152.50	Wickecheoke Creek, NJ	DAY1 WQ1	F	F	F	F	LGR	F	G	G	G		G	G	G	G	G	G	G	G	G	G	C	G	
DRBCNJ0013	154.00	Lockatong Creek, NJ	DAY1 WQ1	F	F	F	F	F	F	G	G	G		G	G	G	G	G	G	G	G	G	G	C	G	
DRBCNJPAC04	155.40	Delaware River @ Bulls Island Footbridge, PA-NJ	DAY1 WQ1	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	
DRBCPA0016	155.60	Paunacussing Creek, PA	DAY2 WQ2	F	F	F	F	F	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G	
DRBCPA0015	157.00	Tohickon Creek, PA	DAY2 WQ2	F	F	F	F	F	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	
DRBCPA0017	159.90	Tinicum Creek, PA	DAY2 WQ2	F	F	F	F	LGR	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G	
DRBCNJ0020	164.10	Nishisakawick Creek, NJ	DAY2 WQ2	F	F	F	F	F	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G	
DRBCNJPAC06	167.70	Delaware River @ Milford, NJ-PA (Frenchtown closed)	DAY2 WQ2	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	
DRBCPA0021	173.70	Cooks Creek, PA	DAY2 WQ2	F	F	F	F	F	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G	
DRBCNJPAC07	174.80	Delaware R @ Riegelsville Br, PA-NJ	DAY2 WQ2	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	
DRBCNJ0025	174.60	Musconetcong River, NJ	DAY2 WQ2	F	F	F	F	S	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	
DRBCNJ0027	177.40	Pohatcong Creek, NJ	DAY3 WQ3	F	F	F	F	F	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G	
DRBCNJPAC08	183.82	Delaware R @ Northampton St Br, PA-NJ	DAY3 WQ3	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	
DRBCPA0026	183.66	Lehigh River, PA	DAY3 WQ3	F	F	F	F	S	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	
DRBCPA0028	184.10	Bushkill Creek, PA	DAY3 WQ3	F	F	F	F	F	F	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G	
DRBCNJ0032	197.80	Pequest River, NJ	DAY3 WQ3	F	F	F	F	S	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	
DRBCNJPAC09	197.84	Delaware R @ Belvidere-Riverton Bridge, NJ-PA	DAY3 WQ3	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	
DRBCNJ0036	207.00	Paulins Kill, NJ	DAY3 WQ3	F	F	F	F	S	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	
DRBCNJPAC10	207.40	Delaware R @ Columbia-Portland Footbr, NJ-PA	DAY3 WQ3	F	F	F	F	S	F	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	
		10X/Summer Summary	n / week =	23	23	23	23	23	23	23	23	23	12	23	23	23	23	23	23	23	23	23	23	17	23	351
			n/year	230	230	230	230	230	230	230	230	230	120	230	230	230	230	230	230	230	230	230	230	170	230	3510

Run	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
WQ1	5/8	5/22	6/5	6/19	7/10	7/24	8/7	8/21	9/11	9/25
WQ2	5/9	5/23	6/6	6/20	7/11	7/25	8/8	8/22	9/12	9/26
WQ3	5/10	5/24	6/7	6/21	7/12	7/26	8/9	8/23	9/13	9/27

Lower Delaware Monitoring Program - Master Site List 1999-2001

With Latitude/Longitude and River Mile Site Locations

Most sites must be located by GPS in 2001.

St	Site No.	RMI	Sampling Site	Latitude	Longitude	DA
NJ	DRBCNJ1338	133.80	Assunpink Creek at Warren St, Trenton, NJ	need		91.40
NJ	DRBCNJ0001	134.34	Delaware River @ Calhoun Street Bridge (NJ side)	N 40 13' 10"	W 74 46' 45"	
NJ/PA	DRBCNJPAC01	134.34	Delaware River @ Calhoun St Bridge, Center Channel	need		
PA	DRBCPA0001	134.34	Delaware River @ Calhoun Street Bridge (PA side)	N 40 13' 14"	W 74 46' 41"	
NJ	DRBCNJ1369	137.10	Delaware River @ Rotary Island, NJ channel	need		
PA	DRBCPA1369	137.10	Delaware River @ Rotary Island, PA channel	need		
NJ/PA	DRBCPA1370	137.10	Delaware River @ Rotary Island, US point	need		
NJ		137.25	Gold Run @ Trenton CC (NJ)	N 40 14' 52"	W 74 49' 16"	1.66
PA	DRBCPA0002	138.00	Buck Creek at Main St, Yardley	N 40 14' 52"	W 74 50' 32"	6.99
PA	DRBCPA0004	138.80	Delaware River @ Yardley Access, PA	N 40 14' 25"	W 74 49' 29"	
NJ	DRBCNJ0002	139.20	Delaware River @ Scudders Falls Access, NJ	N 40 16' 06"	W 74 51' 07"	
PA	DRBCPA0005	139.80	Dyers Creek @ Rt 32 Bridge	N 40 16' 03"	W 74 51' 25"	1.20
NJ	DRBCNJ0003	140.50	Jacobs Creek abv Rt 29	N 40 16' 42"	W 74 51' 13"	13.30
PA	DRBCPA0003	140.60	Houghs Creek above Taylorsville Rd Bridge	N 40 16' 51"	W 74 52' 01"	5.19
NJ	DRBCNJ0004	141.80	Delaware River @ Washington Crossing Bridge (NJ)	N 40 17' 44"	W 74 52' 06"	
NJ/PA	DRBCNJPAC02	141.80	Delaware River @ Washington Crossing Bridge, Composite	need		
PA	DRBCPA0006	141.80	Delaware River @ Washington Crossing Bridge (PA)	N 40 17' 42"	W 74 52' 10"	
NJ	DRBCNJ0005	143.20	Fiddler Creek @ private bridge, Fiddler Creek Rd	N 40 21' 00"	W 74 52' 54"	2.02
PA	DRBCPA0007	144.20	Jericho Creek @ Stony Brook Rd Bridge	N 40 18' 25"	W 74 54' 35"	9.63
NJ	DRBCNJ0006	145.20	Moore Creek @ Iron Bridge Farm	need		10.20
PA	DRBCPA0008	146.30	Pidcock Creek @ Bowmans Wildflower Preserve Bridge	N 40 20' 43"	W 74 56' 45"	12.70
PA	DRBCPA0009	148.50	Aquetong Creek at Mechanic St, New Hope	N 40 21' 38"	W 74 57' 50"	8.01
NJ	DRBCNJ0007	148.55	Delaware River @ Lambertville Boat Access, NJ	need		
NJ	DRBCNJ0008	148.60	Swan Creek @ Union St Bridge, Lambertville	need		3.28
NJ	DRBCNJ0009	148.70	Delaware River @ Lambertville-New Hope Bridge, NJ	need		
NJ/PA	DRBCNJPAC11	148.70	Delaware River @ Lambertville-New Hope Bridge, Composite	need		
PA	DRBCPA0010	148.70	Delaware River @ Lambertville-New Hope Bridge, PA	need		
NJ	DRBCNJ0010	149.50	Alexauken Creek @ Rt 29 bridge	N 40 22' 52"	W 74 56' 54"	
PA	DRBCPA0011	150.50	Primrose Creek @ Phillips Mill Rd off Rt 32, Solebury	need		
NJ	DRBCNJ0011	151.90	Delaware River @ Stockton Bridge, NJ	N 40 24' 12"	W 74 58' 47"	
NJ/PA	DRBCNJPAC03	151.90	Delaware River @ Stockton Bridge, Composite	need		
PA	DRBCPA0012	151.90	Delaware River @ Stockton Bridge, PA	N 40 24' 07"	W 74 58' 48"	
NJ	DRBCNJ0012	152.50	Wickecheoke Creek at Rt 29	N 40 24' 42"	W 74 59' 13"	26.60
NJ	DRBCNJ0013	154.00	Lockatong Creek at Raven Rock Rd	N 40 24' 57"	W 75 01' 05"	23.20
PA	DRBCPA0014	154.50	Cuttalossa Creek @ Cuttalossa Road off Rt 32	N 40 23' 27"	W 75 01' 12"	
NJ	no samples		Delaware River @ Bulls Island Access	N 40 24' 27"	W 75 02' 09"	
NJ	DRBCNJ0014	155.40	Delaware River @ Lumberville-Raven Rock Footbr (NJ)	N 40 24' 28"	W 75 02' 15"	
NJ/PA	DRBCNJPAC04	155.40	Delaware River @ Lumberville-Raven Rock Footbr, Composite	need		
PA	DRBCPA0013	155.40	Delaware River @ Lumberville-Raven Rock Footbr (PA)	N 40 24' 26"	W 75 02' 17"	
PA	DRBCPA0016	155.60	Paunacussing Creek abv Rt 32	N 40 23' 56"	W 75 02' 30"	7.90
PA	no samples		Hickory Creek, PA	need		1.50
PA	DRBCPA0015	157.00	Tohickon Creek at Rt 32	N 40 25' 23"	W 75 04' 00"	112.00
NJ	DRBCNJ0015	159.50	Warsaw Creek @ Rt 29 Bridge	N 40 27' 27"	W 75 04' 07"	1.60

Lower Delaware Monitoring Program - Master Site List 1999-2001

With Latitude/Longitude and River Mile Site Locations

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St	Site No.	RMI	Sampling Site	Latitude	Longitude	DA
NJ	DRBCNJ0016	160.50	Warford Creek @ Rt 29 Bridge	N 40 28' 10"	W 75 03' 45"	1.60
PA	no samples		Smithtown Creek, PA	need		1.00
PA	DRBCPA0017	161.60	Tinicum Creek by Tinicum Cr Rd	N 40 29' 07"	W 75 03' 21"	24.00
NJ	DRBCNJ0017	162.90	Copper Creek @ Rt 29	N 40 30' 47"	W 75 03' 47"	3.27
NJ	DRBCNJ0018	163.10	Delaware River @ Kingwood Access, NJ	need		
NJ	DRBCNJ0019	164.00	Little Nishisakawick Creek @ Rt 29 Bridge	N 40 31' 27"	W 75 03' 14"	3.51
NJ	DRBCNJ0020	164.10	Nishisakawick Creek at Rt 12, Frenchtown	N 40 31' 35"	W 75 03' 07"	11.10
NJ	DRBCNJ0021	164.30	Delaware River @ Frenchtown Bridge (NJ side)	N 40 31' 04"	W 75 03' 53"	
NJ/PA	DRBCNJPAC05	164.30	Delaware River @ Frenchtown Bridge, Composite	need		
PA	DRBCPA0018	164.30	Delaware River @ Frenchtown Bridge (PA side)	N 40 31' 04"	W 75 03' 57"	
NJ	DRBCNJ0022	165.70	Harihokake Creek @ Rt 29 Bridge	N 40 32' 53"	W 75 04' 09"	9.85
NJ	DRBCNJ0023	167.20	Hakihokake Creek @ Bridge St Bridge, Milford NJ	N 40 34' 04"	W 75 05' 44"	17.50
PA	no samples		Delaware River @ Upper Black Eddy Access, PAFBC	need		
NJ	DRBCNJ0024	167.70	Delaware River @ Milford Bridge (NJ side)	N 40 33' 58"	W 75 05' 55"	
NJ/PA	DRBCNJPAC06	167.70	Delaware River @ Milford Bridge, Composite	need		
PA	DRBCPA0019	167.70	Delaware River @ Milford Bridge (PA side)	N 40 33' 56"	W 75 05' 57"	
PA	DRBCPA0020	171.80	Gallows Run @ Rt 611 & 32	N 40 33' 32"	W 75 10' 45"	8.70
PA	DRBCPA0021	173.70	Cooks Creek at Red Bridge Rd	N 40 35' 12"	W 75 12' 43"	29.50
PA	DRBCPA0022	173.90	Delaware River @ Riegelsville, PA Fish Comm Access	N 40 34' 56"	W 75 11' 45"	
NJ	DRBCNJ0025	174.60	Musconetcong River at River Rd	N 40 35' 33"	W 75 11' 12"	156.00
NJ	DRBCNJ0026	174.80	Delaware River @ Riegelsville Bridge, NJ	need		
NJ/PA	DRBCNJPAC07	174.80	Delaware River @ Riegelsville Bridge, Composite	need		
PA	DRBCPA0023	174.80	Delaware River @ Riegelsville Bridge, PA	need		
PA	DRBCPA0024	176.60	Fry's Run at Footbridge by Rt 611	N 40 37' 05"	W 75 12' 11"	6.10
NJ	DRBCNJ0027	177.40	Pohatcong Creek at River Rd	N 40 37' 29"	W 75 11' 10"	57.10
PA	DRBCPA0025	181.00	Delaware River @ Wy-Hit-Tuk Park Access, PA	N 40 40' 05"	W 75 11' 02"	
NJ	DRBCNJ0028	182.00	Lopatcong Creek at Main St, Phillipsburg	N 40 40' 39"	W 75 10' 12"	14.70
PA	DRBCPA0026	183.66	Lehigh River @ Rt 611, Easton, PA	need		1361.00
NJ	DRBCNJ0029	183.82	Delaware River @ Easton-Northampton St Bridge (NJ)	N 40 41' 28"	W 75 12' 14"	
NJ/PA	DRBCNJPAC08	183.82	Delaware River @ Easton, Northampton St Bridge, composite	need		
PA	DRBCPA0027	183.82	Delaware River @ Easton-Northampton St Bridge (PA)	N 40 41' 28"	W 75 12' 17"	
PA	DRBCPA0028	184.10	Bushkill Creek at Rt 611	N 40 41' 43"	W 75 12' 22"	80.00
PA	DRBCPA0029	185.00	Delaware River @ Eddyside Park Swimming Area, PA	N 40 43' 02"	W 75 11' 33"	
PA	DRBCPA0041	189.10	Mud Run @ Rt 611 Bridge	N 40 45' 29"	W 75 11' 25"	6.00
PA	DRBCPA0030	189.20	Delaware River @ Sandt's Eddy Access, PA	N 40 45' 30"	W 75 11' 17"	
PA	DRBCPA0031	190.58	Martins Creek at Little Creek Rd	N 40 47' 05"	W 75 11' 05"	44.50
NJ	DRBCNJ0030	192.90	Buckhorn Creek at Hutchinson Rd	N 40 46' 17"	W 75 07' 54"	11.80
PA	DRBCPA0040	194.32	Oughoughton Creek @ PPL Martins Creek Plant	N 40 47' 30"	W 75 07' 12"	11.90
PA	DRBCPA0032	194.40	Delaware River @ PPL Martins Cr Boat Access, PA	N 40 47' 21"	W 75 07' 07"	
NJ	DRBCNJ0031	197.40	Pophandusing Brook @ Spring St Bridge, Belvidere	N 40 49' 19"	W 75 04' 52"	5.62
NJ	DRBCNJ0032	197.80	Pequest River @ Market St Bridge, Belvidere (spillway)	N 40 49' 44"	W 75 04' 44"	
NJ	DRBCNJ0033	197.80	Pequest River @ Orchard St Bridge (fixed), Belvidere	N 40 50' 03"	W 75 03' 40"	157.00
NJ	DRBCNJ0034	197.84	Delaware River @ Belvidere Bridge (NJ side)	need		

Lower Delaware Monitoring Program - Master Site List 1999-2001

With Latitude/Longitude and River Mile Site Locations

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St	Site No.	RMI	Sampling Site	Latitude	Longitude	DA
NJ/PA	DRBCNJPAC09	197.84	Delaware River @ Belvidere-Riverton Bridge, Composite	need		
PA	DRBCPA0033	197.84	Delaware River @ Belvidere Bridge (PA side)	need		
PA	DRBCPA0034	199.76	Allegheny Creek @ River Rd Bridge	N 40 51' 09"	W 75 05' 33"	9.06
PA	DRBCPA0035	203.00	Delaware River @ Driftstone Campground Access, PA	N 40 52' 27"	W 75 03' 56"	
NJ	DRBCNJ0035	205.20	Delawanna Creek @ Rt 46 bridge	N 40 53' 53"	W 75 04' 21"	4.49
NJ	DRBCNJ0036	207.00	Paulins Kill Creek @ Rt 46 Bridge nr I-80	N 40 55' 15"	W 75 05' 18"	177.00
PA	DRBCPA0037	207.20	Jacoby Creek @ Rt 611 Bridge, Portland	N 40 55' 17"	W 75 05' 46"	6.45
NJ	DRBCNJ0037	207.40	Delaware River @ Columbia-Portland Footbridge (NJ)	N 40 55' 27"	W 75 05' 45"	
NJ/PA	DRBCNJPAC10	207.40	Delaware River @ Columbia-Portland Footbridge, Composite	need		
PA	DRBCPA0036	207.40	Delaware River @ Columbia-Portland Footbridge (PA)	N 40 55' 26"	W 75 05' 47"	
NJ	DRBCNJ0042	208.76	Stony Brook @ Access Rd above Rt 80	need		4.08
PA	DRBCPA0038	209.58	Slateford Creek @ National Park Rd Bridge	N 40 56' 47"	W 75 06' 55"	2.95
NJ	DRBCNJ0038	211.40	Dunnfield Creek @ Appalachian Trail footbridge	N 40 58' 17"	W 75 07' 38"	3.56
PA	no samples		Caledonia Creek, PA	need		1.03
PA	no samples		Brodhead Creek, PA	need		294.00

Directions for Lower Delaware Water Quality (WQ) Sampling Runs 2001.

WQ1 (7 sites):
From DRBC, 29S to Calhoun St Bridge, cross, R onto 32N, park PA side.

1.	Calhoun Street Br.	North 29 to Washington Crossing.
2.	Washington Crossing Br.	Cross bridge, go 32N to Bowmans Wildflower Preserve.
3.	Pidcock Creek, PA.	32N to New Hope, cross over, park in lot NJ side.
4.	Lambertville Bridge	Proceed N 29 to Pralls Mills @ Wickecheoke Cr.
5.	Wickecheoke Creek, NJ	East to Rosemont-Raven Rock Rd. bridge @ Lockatong Cr.
6.	Lockatong Creek, NJ	NW to 29N, left into Bulls Island (Raven Rock Foot Bridge)
7.	Bulls Island Foot Bridge	29S to NJ Analytical Labs off Washington Crossing Rd, home.

WQ2 (8 sites):
From DRBC, 29N to Stockton, cross, 32N to Paunacussing Cr. (1 lane crossing).

1.	Paunacussing Creek, PA	32N to Tohickon Cr., Point Pleasant village.
2.	Tohickon Creek, PA	N 32 to Tinicum Cr., L onto Tinicum Cr. Rd.
3.	Tinicum Creek, PA	N 32 to Milford Bridge (Frenchtown closed 2001)
4.	Milford Bridge	To PA, N 32/611N to 212W, R to Red Bridge Rd @ Cooks Cr.
5.	Cooks Creek, PA	611N to Riegelsville, R on Bridge St, Cross to NJ.
6.	Riegelsville Bridge	In NJ, River Rd. S to Musconetcong River.
7.	Musconetcong River, NJ	River Rd. to Milford, 29S to Frenchtown, Nishisakawick @ Rt 12 Br.
8.	Nishisakawick Cr., NJ	S 29 to NJ Analytical Labs off Washington Crossing Rd, home.

WQ 3 (8 sites):
From DRBC, 29N to Milford, River Rd. to Riegelsville Br., River Rd. N to Pohatcong Cr.

1.	Pohatcong Creek, NJ	N on local roads to Phillipsburg – Main St. to Easton Bridge.
2.	Northampton Br., Easton	To PA, N 611 to Belvidere Br., to NJ, 519N-46W to Paulins Kill.
3.	Paulins Kill, NJ	N into Columbia, do C-P footbridge, park NJ side
4.	Columbia-Portland Ft.Br.	46 E. to R at Belvidere, to Pequest River, (Orchard St. Br.)
5.	Pequest River, NJ	Into Belvidere, park NJ side of Belvidere Bridge.
6.	Belvidere Bridge	Cross to PA side, S 611 to Bushkill Creek, Easton, PA.
7.	Bushkill Creek, PA	Go S 611 to McDonalds lot & Lehigh River, PA
8.	Lehigh River, PA	611S, cross at Milford, 29S to NJ Analytical Labs or home.